# JOURNAL OF DAIRY SCIENCE

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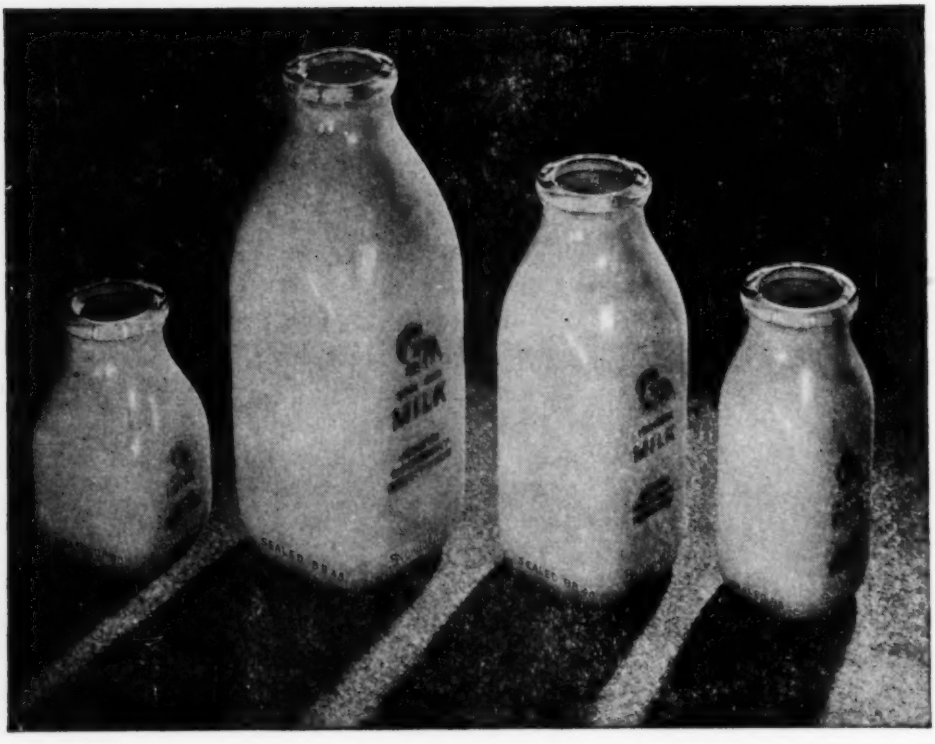


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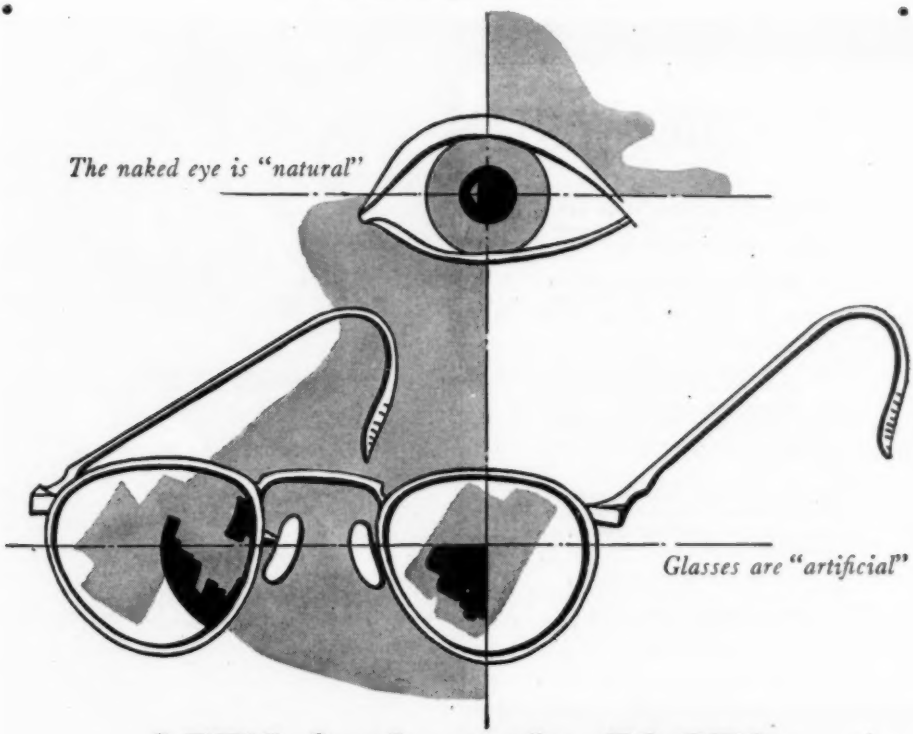


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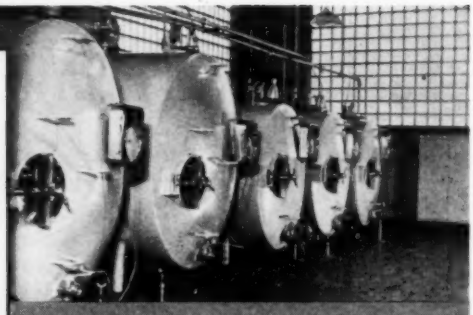

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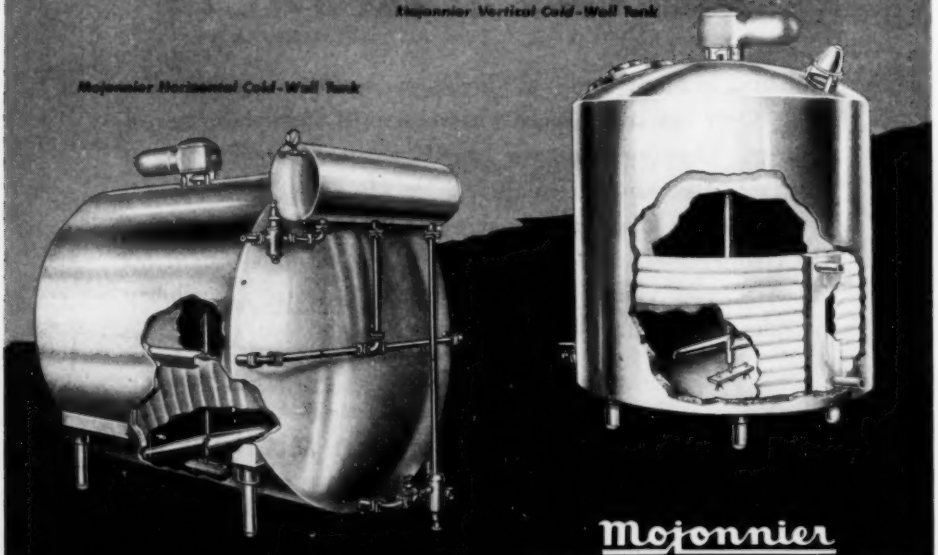

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JOURNAL OF DAIRY SCIENCE

VOLUME XXIX DECEMBER, 1946 NUMBER 12

# SHARK MEAL AS A PROTEIN SUPPLEMENT IN DAIRY CALF RATIONS[1]

SIDNEY P. MARSHALL,[2] R. B. BECKER, AND GEORGE K. DAVIS

*Florida Agricultural Experiment Station, Gainesville, Florida*

Shark meal is a relatively new livestock feedstuff which has been found to contain an average of 78.07 per cent of crude protein and which is high in calcium and phosphorus contents. The production of shark meal has been reviewed briefly by Marshall and Davis (9). During the past 6 years the output of this product in Florida and along the Pacific seaboard has reached significant proportions.

The value of fish meals as protein supplements in rations of young dairy calves has been reported by several investigators, but no literature has been observed on the evaluation of shark meal as a protein source for calves. Since sharks, class *Chondrichthyes*, whose skeletons are cartilaginous, are different from the bony fishes, class *Osteichthyes* (6), information was needed on the feeding value of shark meal as a protein supplement in rations for dairy calves.

## LITERATURE

Little is known of the protein requirements of dairy calves under 6 months of age. Although many rations have been used satisfactorily to supplement milk during the first few weeks of life and later to replace it in the dietary of the young calf, few studies have yielded information on the minimum amount of protein required to produce an optimum rate of growth through 6 months of age.

Early feeding standards for dairy calves were formulated by Wolff, Lehman, and by Armsby. However, in discussing these standards, Eckles and Gullickson (3) pointed out that many of the data from which these recommendations were derived are of limited or doubtful value as applied to growing dairy calves. The minimum digestible crude protein allowance recommended for young dairy calves by the Morrison standard (11) increases from 0.24 pound daily at 100 pounds live weight to 0.61 pound at 250 pounds live weight.

Received for publication June 10, 1946.

[1] Taken from data presented in a thesis to graduate faculty of the University of Minnesota by Sidney P. Marshall in partial fulfillment of the requirements for the degree of Doctor of Philosophy.

[2] Now at Clemson Agricultural College, Clemson, South Carolina.



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At the Cornell station (5), Holstein calves fed *ad libitum* on a ration containing 8.3 per cent of crude protein (dry basis) produced very slow growth. Those fed rations containing 11.7 and 15.2 per cent of crude protein grew at a rate slightly below the Ragsdale normal (12), and an 18.8 per cent crude protein ration produced gains slightly above the normal. Nitrogen balances conducted on male calves approximately 10 and 15 weeks of age showed about equal nitrogen storage on the rations containing 15.2 and 18.8 per cent of crude protein, but an appreciably lower level of retention by those fed the other 2 protein levels. Harris (4) stated that the minimum requirement of Holstein calves 8 to 16 weeks of age lies between 11 and 14 per cent of crude protein in the ration.

For the investigation reported herein, the experimental rations were formulated to contain 14 per cent of crude protein, a level thought to be near the minimum which would support a normal rate of growth in dairy calves 8 to 24 weeks of age. Roller process powdered skim milk was selected as a protein source of recognized good quality with which to compare the feeding value of the nitrogenous constituents present in shark meal.

## EXPERIMENTAL PROCEDURE

Several Jersey heifer calves at the Florida Agricultural Experiment Station were raised through 7 weeks of age on limited amounts of whole milk and a simple dry ration containing shark meal as the protein supplement. On the basis of age, weight, and general thrift, at about 8 weeks of age, 12 calves were paired and started on the experiment.

The basal rations were composed of prairie hay (No. 1 federal grade) ground to pass through a ¼-inch screen, 9 per cent of citrus molasses (1), 3 per cent of mineral mixture, and equal parts of ground yellow corn and ground oats. To the basal ration, the necessary amount of shark meal or of powdered skim milk was added to raise the total crude protein content of the ration to 14 per cent. Corn starch was included in the shark meal rations to adjust the quantity of nitrogen contributed by this protein supplement per pound of total feed to equal that per pound of total feed supplied by the powdered skim milk to the other rations. To comply with changes in the capacity of the young calf's stomach to utilize roughage, the proportion of hay to concentrates was altered with advancing age to approximate the records of hay and grain mixture consumption reported by Eckles (2) for Jersey calves raised by a limited milk feeding plan. The rations fed (table 1) contained 35 per cent of prairie hay during the first 4-week period, 40 per cent during the second, 45 per cent during the third, and 50 per cent during the fourth.

Rations containing shark meal, designated as rations 1, were fed to calves 1, 3, 5, 7, 9, and 11. Those containing powdered skim milk, designated as rations 2, were given to calves 2, 4, 6, 8, 10, and 12. The calves were paired as follows: 1 and 2, 3 and 4, 5 and 6, 7 and 8, 9 and 10, 11 and 12. Feed con-

sumption of the calves of each pair was equalized by the paired feeding technique (10).

TABLE 1

*Ingredients of calf rations used in comparing shark meal with powdered skim milk as a protein supplement*

| Ingredient | Rations 1 (%) | Rations 2 (%) |
|---|---|---|
| **Period 1** | | |
| Ground prairie hay | 35.0 | 35.0 |
| Citrus molasses | 9.0 | 9.0 |
| Ground yellow corn | 12.7 | 12.7 |
| Ground oats | 12.7 | 12.7 |
| Mineral mixture* | 3.0 | 3.0 |
| Shark meal | 14.63 | ..... |
| Corn starch | 12.97 | ..... |
| Powdered skim milk | ..... | 27.60 |
| **Period 2** | | |
| Ground prairie hay | 40.0 | 40.0 |
| Citrus molasses | 9.0 | 9.0 |
| Ground yellow corn | 9.55 | 9.53 |
| Ground oats | 9.55 | 9.53 |
| Mineral mixture* | 3.0 | 3.0 |
| Shark meal | 15.30 | ..... |
| Corn starch | 13.60 | ..... |
| Powdered skim milk | ..... | 28.94 |
| **Period 3** | | |
| Ground prairie hay | 45.0 | 45.0 |
| Citrus molasses | 9.0 | 9.0 |
| Ground yellow corn | 6.37 | 6.4 |
| Ground oats | 6.37 | 6.4 |
| Mineral mixture* | 3.0 | 3.0 |
| Shark meal | 13.33 | ..... |
| Corn starch | 16.93 | ..... |
| Powdered skim milk | ..... | 30.20 |
| **Period 4** | | |
| Ground prairie hay | 50.0 | 50.0 |
| Citrus molasses | 9.0 | 9.0 |
| Ground yellow corn | 2.46 | 2.46 |
| Ground oats | 2.46 | 2.46 |
| Mineral mixture* | 3.0 | 3.0 |
| Shark meal | 14.12 | ..... |
| Corn starch | 18.96 | ..... |
| Powdered skim milk | ..... | 33.08 |

* The mineral mixture was composed of: defluorinated superphosphate, 48%; sodium chloride, 20%; potassium chloride, 13.3%; magnesium oxide, 13.3%; ferric chloride, 4%; manganous sulfate, 0.67%; copper sulfate, 0.28%; cobalt sulfate, 0.15%; zinc oxide, 0.15%, and potassium iodide, 0.15%.

Ten milliliters of shark-liver oil containing approximately 9,000 International Units of vitamin A per gram were mixed with a portion of the afternoon's rations on each Tuesday, Thursday, and Saturday.

TABLE 2

*Biweekly live weights and total gains of calves*

| Week of experiment | Rations 1 (containing shark meal) | | | | | | | Rations 2 (containing powdered skim milk) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Calf 1 | Calf 3 | Calf 5 | Calf 7 | Calf 9 | Calf 11 | Average | Calf 2 | Calf 4 | Calf 6 | Calf 8 | Calf 10 | Calf 12 | Average |
| | *lbs.* | *lbs.* | *lbs.* | *lbs.* | *lbs.* | *lbs.* | *lbs.* | *lbs.* | *lbs.* | *lbs.* | *lbs.* | *lbs.* | *lbs.* | *lbs.* |
| Initial | 86.5 | 95.0 | 78.5 | 94.5 | 92.5 | 92.5 | 89.9 | 90.0 | 93.5 | 86.5 | 98.0 | 78.0 | 92.5 | 89.8 |
| 2 | 92.0 | 119.0 | 97.5 | 100.5 | 101.5 | 104.0 | 102.4 | 92.0 | 108.0 | 97.5 | 103.0 | 85.0 | 106.0 | 98.6 |
| 4 | 111.0 | 124.0 | 108.5 | 107.5 | 106.0 | 107.0 | 110.7 | 110.0 | 116.0 | 110.0 | 106.5 | 92.0 | 108.5 | 107.2 |
| 6 | 121.0 | 130.0 | 120.0 | 116.0 | 124.5 | 128.0 | 123.3 | 121.0 | 119.0 | 107.5 | 119.0 | 113.0 | 132.0 | 118.6 |
| 8 | 129.0 | 148.5 | 133.0 | 142.0 | 133.5 | 149.5 | 139.3 | 132.0 | 141.0 | 131.0 | 143.0 | 127.0 | 148.5 | 137.1 |
| 10 | 146.0 | 172.0 | 152.5 | 160.0 | 155.5 | 162.5 | 158.1 | 145.0 | 157.0 | 146.5 | 164.0 | 146.5 | 168.5 | 154.6 |
| 12 | 159.0 | 185.0 | 171.5 | 177.5 | 175.0 | 180.0 | 174.7 | 154.0 | 182.0 | 163.5 | 182.5 | 161.5 | 181.5 | 170.8 |
| 14 | 189.0 | 207.0 | 183.0 | 188.0 | 185.0 | 188.5 | 190.1 | 183.0 | 191.0 | 179.0 | 195.0 | 175.0 | 199.0 | 187.0 |
| 16 | 208.0 | 229.5 | 205.5 | 209.0 | 195.0 | 203.0 | 208.3 | 204.0 | 222.5 | 202.0 | 214.0 | 194.0 | 205.0 | 206.9 |
| Total gain | 121.5 | 134.5 | 127.0 | 114.5 | 102.5 | 110.5 | 118.4 | 114.0 | 129.0 | 115.5 | 116.0 | 116.0 | 112.5 | 117.1 |

The calves were housed in individual pens in a barn on a concrete floor bedded with excelsior. Except for a few days of inclement weather, the animals were kept from noon until 4 o'clock each afternoon in an outside lot with concrete floor.

The calves were fed twice daily and water was kept before them at all times. Live weights were taken prior to the afternoon feeding the day before the experiment was begun and at weekly intervals thereafter. Weights taken on 3 successive days at the close of the experiment were used to calculate the final weight. On each weigh day, measurements were taken of the height at withers. For each animal, the average of 3 measurements falling within a range of 1 centimeter was used as the height.

## RESULTS

The average initial live weight of the calves fed the shark meal rations was 89.9 pounds; those that received powdered skim milk rations averaged 89.8 pounds. Differences in initial body weight between individuals of each pair ranged from 0 to 14.5 pounds.

After 16 weeks of experimental feeding, the 6 calves on shark meal rations averaged 208.3 pounds in body weight and those fed powdered skim milk rations averaged 206.9 pounds. Differences in final body weights of pair mates ranged from 1.5 to 13.5 pounds. Live weights at biweekly intervals, average biweekly weights of all calves fed each ration, the total gain of each calf, and the average gain of the calves fed each ration are shown in table 2.

At the beginning of the experiment, the average height at withers was

TABLE 3

*Weekly feed consumption for each calf and the average for calves fed each ration*

| Week of experiment | Calf 1 or 2 | Calf 3 or 4 | Calf 5 or 6 | Calf 7 or 8 | Calf 9 or 10 | Calf 11 or 12 | Rations 1 or 2 |
|---|---|---|---|---|---|---|---|
| | *lbs.* | *lbs.* | *lbs.* | *lbs.* | *lbs.* | *lbs.* | *lbs.* |
| 1 | 14.1 | 20.0 | 21.0 | 17.0 | 17.0 | 20.8 | 18.3 |
| 2 | 19.0 | 26.5 | 26.5 | 21.5 | 21.0 | 26.0 | 23.4 |
| 3 | 21.3 | 27.0 | 27.0 | 28.0 | 28.0 | 28.0 | 26.6 |
| 4 | 29.0 | 28.0 | 28.0 | 28.0 | 28.3 | 41.3 | 30.4 |
| 5 | 35.5 | 29.0 | 29.0 | 44.0 | 43.8 | 52.5 | 39.0 |
| 6 | 41.0 | 45.0 | 45.5 | 52.5 | 53.5 | 52.5 | 48.3 |
| 7 | 42.5 | 54.8 | 54.0 | 54.5 | 56.0 | 53.0 | 52.5 |
| 8 | 49.0 | 55.5 | 56.0 | 54.3 | 55.0 | 48.0 | 53.0 |
| 9 | 48.5 | 57.5 | 56.5 | 49.0 | 48.0 | 52.5 | 52.0 |
| 10 | 47.3 | 49.5 | 53.0 | 52.5 | 52.5 | 54.5 | 51.6 |
| 11 | 49.0 | 59.5 | 59.5 | 54.5 | 55.0 | 57.0 | 51.7 |
| 12 | 49.0 | 61.0 | 60.5 | 57.0 | 57.0 | 57.0 | 56.9 |
| 13 | 53.0 | 65.0 | 64.0 | 53.0 | 60.5 | 64.0 | 59.9 |
| 14 | 62.5 | 64.0 | 63.0 | 59.0 | 64.0 | 70.0 | 63.8 |
| 15 | 70.0 | 71.0 | 71.0 | 63.0 | 70.0 | 70.0 | 69.2 |
| 16 | 75.0 | 77.0 | 77.0 | 67.5 | 70.0 | 74.0 | 73.4 |

**Note: When the weekly feed consumption of the calves in each pair was not equal, an average value is given.**

72.4 centimeters for the animals placed on the shark meal rations and 72.8 centimeters for those on powdered skim milk rations. During the 16 weeks of the experiment, the average height of each group increased to 88.7 centimeters.

Feed consumption of the calves fed each ration averaged 18.3 pounds for the first week of the experiment. By the final week, the level of feed intake had increased to an average of 73.4 pounds. The weekly feed consumption of each calf and the average for the calves fed each ration are presented in table 3.

The composition of the calf rations as calculated from the analyses of their ingredients is presented in table 4. Rations fed during the same periods are similar in composition. During the successive periods, 1 through

TABLE 4

*Composition of calf rations as calculated from analyses of ingredients*

| Ration number | Water (%) | Crude protein (%) | Ether extract (%) | Crude fiber (%) | Nitrogen-free extract (%) | Ash (%) | Ca (%) | P (%) | Mg (%) |
|---|---|---|---|---|---|---|---|---|---|
| Period 1 | | | | | | | | | |
| 1 | 14.88 | 14.00 | 2.61 | 10.96 | 48.28 | 9.50 | 1.439 | 0.540 | 0.458 |
| 2 | 12.70 | 14.00 | 2.03 | 11.00 | 51.26 | 9.00 | 1.102 | 0.547 | 0.448 |
| Period 2 | | | | | | | | | |
| 1 | 14.78 | 14.00 | 2.44 | 12.01 | 47.32 | 9.69 | 1.481 | 0.541 | 0.440 |
| 2 | 12.49 | 14.00 | 1.83 | 12.06 | 50.45 | 9.17 | 1.130 | 0.548 | 0.429 |
| Period 3 | | | | | | | | | |
| 1 | 14.19 | 14.00 | 1.74 | 13.05 | 48.68 | 8.99 | 1.283 | 0.509 | 0.390 |
| 2 | 12.29 | 14.00 | 1.62 | 13.12 | 49.61 | 9.34 | 1.156 | 0.548 | 0.411 |
| Period 4 | | | | | | | | | |
| 1 | 14.06 | 14.00 | 1.48 | 14.04 | 47.98 | 9.13 | 1.318 | 0.503 | 0.448 |
| 2 | 13.00 | 14.00 | 2.74 | 14.06 | 46.39 | 9.81 | 1.221 | 0.621 | 0.434 |

4, there were increases in crude fiber and reductions in nitrogen-free extract in the rations. These changes in composition were caused by the periodic augmentations in the proportion of prairie hay in the rations.

## DISCUSSION

The amount of feed offered was limited in each pair by the quantity that the calf with the poorer appetite would consume. Shark meal and powdered skim milk rations appeared to be equally palatable, and feed allowances were determined as frequently by the calves fed rations 1 as by those fed rations 2.

During the first few weeks on the dry experimental rations, feed consumption was low and calves gained slowly. Following an increase in feed consumption during the fourth week, the growth rate improved but continued slightly below the normal. At times during the ninth through eleventh weeks in the experiment, most of the calves had mild cases of diar-

rhea. Inappetence occurred in the affected calves, and the average feed consumption of the animals did not increase during this period. The average rate of gain and the weekly feed consumption of calves fed each of the rations is shown in figure 1.

The calves fed the shark meal rations made an average gain of 118.4 pounds in body weight and 16.3 centimeters in height at withers. The pair mates fed the powdered skim milk rations gained 117.1 pounds and increased 15.9 centimeters in height at withers. Neither the difference in mean gain between the two groups nor the difference in increase in height at withers is significant at the 5 per cent level (13).

Chemical analyses of the shark meal used during the periods 1 and 2 revealed that 1.264 per cent of nitrogen was present in the form of urea, and

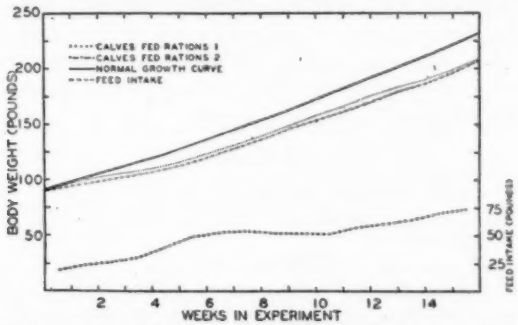


FIG. 1. Average weekly feed intake and average growth rate (running averages) of calves fed rations 1, containing shark meal, and of calves fed rations 2, containing powdered skim milk. The normal growth curve for Jersey females reported by Ragsdale (12) is included for comparison.

in a fraction of non-protein nitrogen other than urea. The shark meal used during periods 3 and 4 contained 1.421 per cent of nitrogen in these forms. These non-protein compounds contain a larger percentage of nitrogen than do proteins. Therefore, when the conventional factor $N \times 6.25$ is used to convert the nitrogen of shark meal into crude protein, the value obtained exceeds the total amounts of nitrogenous constituents present. As a result, that total of the feedstuff analyses of the shark meal rations slightly exceeds 100 per cent (table 4).

Researches by many investigators have indicated that ruminants, through the medium of rumen flora and fauna, are able to use some non-protein nitrogen in the dietary. Loosli, McCay, and Maynard (8) and Loosli and McCay (7) observed that Holstein calves approximately 2 months of age were able to utilize some urea as a source of dietary nitrogen. Calves weaned at approximately 2 months of age and continued on a basal ration containing about 4.4 per cent of protein gained an average of 7 pounds in 2 months, while those receiving 4 per cent of urea in the basal ration were 75 to 90 per

cent of the normal in weight at 4 months of age. At 3 to 4 months of age, calves fed the low-protein diet were in a negative nitrogen balance, while those fed the basal diet plus urea were able to store nitrogen. These investigations indicate that the non-protein nitrogen present in shark meal may have been utilized by the calves in the studies reported herein.

## SUMMARY

Shark meal was compared with roller process powdered skim milk as a protein supplement in simple rations fed to Jersey calves. Using the paired feeding technique, 6 pairs of females were fed 8 to 24 weeks of age on rations containing 14 per cent of protein.

The 6 calves fed the shark meal rations made an average gain of 118.4 pounds in body weight and 16.3 centimeters in height at withers. Their pair mates fed the powdered skim milk rations gained 117.1 pounds and increased 15.9 centimeters in height at withers. The difference in growth rate is not significant at the 5 per cent level. The average rate of growth was slightly below the normal reported for Jersey females.

## ACKNOWLEDGMENT

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## REFERENCES

(1) Becker, R. B., Arnold, P. T. Dix, Davis, G. K., and Fouts, E. L. Citrus Molasses—a New Feed. Jour. Dairy Sci., **27**: 269–273. 1944.

(2) Eckles, C. H. Dairy Cattle and Milk Production. Revised ed., 591 pp. The Macmillan Co., New York, N. Y. 1935.

(3) Eckles, C. H., and Gullickson, T. W. Nutrient Requirements for Normal Growth of Dairy Cattle. Jour. Agr. Res., **42**: 603–616. 1931.

(4) Harris, L. E. Information on the Minimum Protein Requirements of Holstein Calves. Ithaca, N. Y. Private communication. 1944.

(5) Harris, L. E., and Loosli, J. K. The Minimum Protein Requirements of Young Holstein Calves. Jour. Dairy Sci., **27**: 650–651. 1944.

(6) Hyman, L. H. Comparative Vertebrate Anatomy. Ed. 2, 544 pp. The Univ. of Chicago Press, Chicago, Ill. 1942.

(7) Loosli, J. K., and McCay, C. M. Utilization of Urea by Young Calves. Jour. Nutr., **25**: 187–202. 1942.

(8) Loosli, J. K., McCay, C. M., and Maynard, L. A. Utilization of Urea by Calves Less than Four Months of Age. Jour. Dairy Sci., **25**: 680–681. 1942.

(9) Marshall, Sidney P., and Davis, G. K. The Value of Shark Meal in Swine Rations. Jour. Anim. Sci., **5**: 211–218. 1946.

(10) Mitchell, H. H., and Beadles, J. R. The Paired-Feeding Method in Nutrition Experiments and Its Application to the Problem of Cystine Deficiencies in Food Proteins. Jour. Nutr., **2**: 225–243. 1930.

(11) Morrison, F. B. Feeds and Feeding. Ed. 20, 1050 pp. The Morrison Publishing Co., Ithaca, N. Y. 1936.

(12) Ragsdale, A. C. Growth Standards for Dairy Cattle. Mo. Agr. Expt. Sta. Bul. 336. 1934.

(13) Snedecor, G. W. Statistical Methods. 341 pp. Collegiate Press Co., Ames, Ia. 1938.

# COLOSTRUM MILK AND ITS VITAMIN A CONTENT

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## INTRODUCTION

In 1933 Dann (1) suggested that the calf received from twenty to fifty times as much vitamin A from colostrum as from an equal volume of whole milk. He observed that the vitamin A content of colostrum varied widely in cows of the same breed receiving identical rations and that the vitamin A potency of the colostrum from five heifers studied was double the average of that of nine older cows. Stewart and McCallum (2) related certain types of infections in young calves to the vitamin A content of the colostrum from their dams. These workers (3) observed a hundred cows from several herds, which presumably received similar rations, and suggested that the length of the dry period prior to parturition significantly effected colostral vitamin A. They reported no difference due to the age of the cow. Wide variations in vitamin A content of colostrum have been reported by Dann (1), Semp *et al.* (4), Stewart and McCallum (3) and others (5, 6, 7).

Vitamin A deficiency was observed in cows on the classical experiments of Hart *et al.* (8) and its effect on the newborn calf was noted. Jones *et al.* (9) produced a vitamin A deficiency in the calf and recorded the symptoms. Krauss (10) analyzed the livers of newborn calves and found them low in vitamin A. Phillips *et al.* (11) observed symptoms in young calves under certain farm conditions that responded to vitamin therapy, and further, as a result of blood plasma studies it was concluded that calves are born uniformly deficient in vitamin A. Sutton *et al.* (12) observed a decrease in blood plasma vitamin A in the cow concurrent with its appearance in the colostrum. It is generally assumed that colostrum supplies adequate amounts of vitamin A to meet the needs of the very young calf. The appearance of vitamin A deficiency symptoms in calves, including low blood plasma A concentrations suggests that a low vitamin A content of the colostrum may be responsible for these symptoms. We are aware that this suggestion does not preclude the possibility of poor absorption of the vitamin A present in the colostrum.

In an attempt to obtain further information on this subject a study was made of the vitamin A content of colostrum milk. Our approach to the problem was to determine the variation in vitamin A of colostral milks from cows which were maintained and milked under uniform conditions.

## EXPERIMENTAL

*Feeding of cows.* Eighteen first-calf heifers were available for observation. Without access to pasture, they were fed and maintained throughout

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the experiment on a ration composed of medium quality alfalfa hay, corn silage, and a grain mixture (ground yellow corn 550, corn gluten 200, iodized salt 10 and bone meal 8). They were placed under observation at three to four weeks of age and were given rations, that were identical from the standpoint of vitamin A potency, in such proportions as to supply one-third of the daily requirement for T.D.N. respectively, from the grain, hay and silage. The heifers were bred to freshen at approximately thirty months and again at forty-two months of age, with a dry period of approximately two months between lactations. Other colostrum samples were available from Holstein, Jersey, and Guernsey cows from the regular university herd at different times throughout the year as well as from a few farm herds.

*Collection of colostrum samples.* Only those samples were used which were obtained from cows *milked out completely.* The cows were milked out at the first regular milking period following parturition and every twelve hours thereafter. Representative samples were taken of the first two milkings and if it was not convenient for immediate analysis they were frozen and stored in a darkened room at $-4°$ C.

*Method of analysis.* It was found that little loss occurred in vitamin A potency if the milk was kept in the dark in a frozen state for periods up to thirty days. In these experiments analyses were made within fourteen days of collection. The milk was thawed with the aid of warm water and homogenized with a small hand homogenizer. Vitamin A and carotene determinations were made according to the method of Boyer *et al.* (13).

## RESULTS

*Heifers as compared to cows.* Table 1 shows the individual carotene and vitamin A values of the colostrum obtained from eighteen Holstein cows that had been maintained under uniform conditions. The colostral vitamin A concentration of the milk of the first lactation was found to be more than double that of the second lactation. There was little difference in the average carotene values of the colostrum from the two lactations, despite individual variation.

*Variation in cows of the same age.* Table 1 also shows a wide variation in colostral vitamin A potency, between cows of the same age *that had been fed identical rations* for a two-year period previous to parturition. In the first lactation a range in vitamin A concentration of 70–480 micrograms per 100 ml. of colostrum was observed or about a seven-fold variation between cows fed and managed alike. Carotene potency showed much less variation. In general a high vitamin A potency colostrum was accompanied by a high carotene content.

*Effect on the calf.* Table 2 is a summary of data relative to the calves of the second lactation from the cows whose colostral A analysis were given in table 1. The calves were removed from the cows at birth. The cows were milked out completely at regular twelve-hour intervals and the milk

TABLE 1

*The effect of lactation on the vitamin A content of colostrum*

| Cow No. | Vitamin A* | | Carotene* | | Days dry |
|---|---|---|---|---|---|
| | 1st lactation | 2nd lactation | 1st lactation | 2nd lactation | |
| 1 | 410 | 58 | 132 | 59 | 40 |
| 2 | 199 | 176 | 148 | 230 | 61 |
| 3 | 70 | A | 75 | A | ..... |
| 4 | 370 | 167 | 197 | 236 | 46 |
| 5 | 189 | 175 | 77 | 196 | 51 |
| 6 | 393 | A | 96 | A | ..... |
| 7 | 480 | 234 | 200 | 212 | 60 |
| 8 | 355 | 179 | 228 | 195 | 57 |
| 9 | 321 | A | 177 | A | ..... |
| 10 | 190 | A | 100 | A | ..... |
| 11 | 330 | 56 | 143 | 79 | 54 |
| 12 | 475 | 135 | 176 | 119 | 52 |
| 13 | 292 | X | 99 | X | ..... |
| 14 | 301 | 74 | 89 | 105 | 87 |
| 15 | 195 | 127 | 126 | 124 | 58 |
| 16 | 313 | 138 | 181 | 173 | 61 |
| 17 | 214 | 156 | 131 | 181 | 57 |
| 18 | 439 | 57 | 130 | 69 | 49 |
| Ave. | 308 | 133[12] | 139 | 152[12] | ..... |

* Ave. first two milkings μg./100 ml.
A = aborted.
X = This cow was slaughtered before she freshened.

was sampled for vitamin A analysis then given to the calves at the rate of 12 pounds of milk per 100 pounds of body weight. Blood plasma vitamin A determinations were made on the calves before feeding, at one day of age, and on the 7th and 14th days respectively. On the 14th day the calves were weighed.

It is again clearly demonstrated by the data in table 2 that the calf is born with an extremely low but somewhat variable blood plasma vitamin A

TABLE 2

*The effect of the level of vitamin A ingested on the blood plasma vitamin A level and growth of the calf*

| | Micrograms per 100 ml. | | | | Pounds |
|---|---|---|---|---|---|
| | Initial blood blood plasma vitamin A | Colostral vitamin A intake | Increase in blood plasma vitamin A (24 hours) | Ave. blood plasma vitamin A values for period | Gain 2-week period |
| 4 | 2 | 167 | 9 | 11 | 10 |
| 5 | 3 | 175 | 8 | 9 | 0 |
| 7 | 2 | 234 | 12 | 11 | 10 |
| 8 | 6 | 179 | 3 | 12 | 16 |
| 11 | 6 | 56 | 7 | 15 | 18 |
| 12 | 1 | 135 | 6 | 8 | 12 |
| 15 | 5 | 127 | 9 | 10 | 17 |
| 16 | 2 | 138 | 5 | 7 | 8 |
| 17 | 6 | 156 | 10 | 15 | 22 |
| 18 | 4 | 57 | 2 | 8 | 10 |

concentration. This is in agreement with previous observations and with those of the Maryland, and the Ohio workers (14, 7). After the ingestion of colostrum the blood plasma concentration of vitamin A increased markedly. There was an apparent difference in the ability of the calves to utilize the vitamin A present in the colostrum. However, in cases where the colostral A was high the blood plasma vitamin A usually reached a satisfactory concentration. There appeared to be a relationship between the average blood plasma vitamin A level during the 14-day period and the amount of weight gained by the calf in the same period.

TABLE 3

*The effect of milking procedure on the vitamin A content of the colostrum*

| Lot | I | II | III |
|---|---|---|---|
| No. cases | 13 | 4 | 8 |
| | *Vit. A. μg./100 ml.* | | |
| 1st milking | 131 | 239 | 318 |
| 2nd milking | 135 | 134 | 226 |

*Effect of milking procedure.* Samples of colostrum were available from Holstein, Jersey and Guernsey cows that received three different types of treatment following parturition. All cows were milked out completely with the aid of a milking machine at twelve-hour intervals. The cows in lot I were isolated from their calves. The cows in lot II were allowed to remain with the calves throughout the experimental period. The cows in lot III were isolated from their calves but they were given 10 I.U. of oxytocin intravenously at the time of milking to stimulate complete letdown of milk. Colostrum samples were taken at the first, second, third, sixth, and tenth milking in all groups.

Table 3 shows the average colostral vitamin A values from the first and second milkings for these three groups. Although individual variation was noted, it appears that cows treated with oxytocin (lot III) and cows left with their calves in addition to being milked out (lot II) produced colostrum of a much lower vitamin A potency in the second milking as compared to the first. This was not the case with cows which were isolated from their calves and milked out in a normal manner, since the average vitamin A potency of the colostrum from the first and second milking of these cows was the same. It should be pointed out, however, that the initial vitamin A level in the colostrum from the cows in lot I was lower than that from the cows in lots II and III. This may be accounted for by feeding differences as these cows were maintaned under barn feeding conditions (without pasture) throughout the year while the cows in lots II and III were allowed access to pasture.

*Change from colostrum to normal.* Table 4 shows the rate of change from colostrum to normal milk with respect to vitamin A, and represents

TABLE 4

*The rate of change in vitamin A concentration from colostrum to normal milk*

| | No. of milking | | | | | Normal |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 6 | 10 | |
| Carotene in I.U./10 lbs. milk | 63,500 | 38,440 | 20,200 | 13,600 | 6,000 | 1,720 |
| Vitamin A in I.U./10 lbs. milk | 52,600 | 35,200 | 19,500 | 14,800 | 9,700 | 3,140 |

the average analyses of the twelve cows comprising lots II and III (see above). The control milk vitamin A concentration figures were obtained by analysis of milk from six of these cows in mid lactation. There was essentially no difference between lot II and III in the rate of change with reference to vitamin A levels in colostrum to that of normal milk. The data show that the main drop in vitamin A occurred during the first three milkings.

## DISCUSSION

These results are in agreement with the work of Dann (1) and Henry *et al.* (5) who suggested that the colostrum from heifers was a richer source of vitamin A than the colostrum from older cows. If the length of the dry period affects the vitamin A potency of colostrum as reported by Stewart and McCallum (3), it is surprising that these workers did not observe a difference in colostral A potency between heifers and older cows.

It should be emphasized that cows of uniform age which had received identical rations varied widely in the vitamin A content of their respective colostral milks. Assuming that the intake of the calf during the first day was ten pounds of milk the variability in vitamin A intake by the calf would be from 10,000–86,400 I.U. per day. The lower range of vitamin A ingestion calculated here has been shown to be borderline in meeting the vitamin A requirements of the newborn calf (15). Add to this the hazards of limited nursing, congestion of the udder and nursing habits of the young calf and it is evident that some calves which receive colostrum may be deficient in vitamin A and may at times exhibit various deficiency symptoms.

## SUMMARY

A study of the vitamin A concentration of colostral milk has been made. The vitamin A content of the colostrum from barn-fed heifers in the first lactation was found to be more than double the vitamin A content of the colostrum from the same cows in the second lactation. A seven-fold variation in colostral vitamin A potency occurred in these cows which had been fed identical rations and maintained under uniform conditions.

A marked increase in the blood plasma vitamin A concentration of the newborn calf followed the ingestion of colostrum and tended to reflect the concentrations of vitamin A present in the colostrum of their dams.

With cows isolated from their calves the vitamin A potency of their colostrum of the first and second milkings was about the same. However, cows which were allowed to remain with their calves and in addition were milked out twice daily showed a decided drop in vitamin A potency between the first and second milking. The intravenous injection of 10 I.U. of oxytocin at the time of milking in cows isolated from their calves also produced a similar drop in vitamin A potency between the first and the second milking.

The chief drop in concentration of vitamin A in the change from colostrum to normal milk occurred during the first three milkings following parturition, thereafter there was a gradual drop in vitamin A concentration over a period of several days to the concentration found in milk produced in mid-lactation.

## REFERENCES

(1) DANN, W. J. The Carotene and Vitamin A Content of Cows Colostrum. Biochem. Jour., 27: 1998–2005. 1933.

(2) STEWART, J., AND MCCALLUM, J. W. White Scours in Calves and Related Infections. I. The Significance of the Vitamin A Content of the Colostrum as a Predisposing Factor in the Causation of Such Conditions. Jour. Compar. Path. and Ther., 51: 290–295. 1938.

(3) STEWART, J., AND MCCALLUM, J. W. The Vitamin A Content of the Colostrum of Dairy Cows. Jour. Agr. Sci., 28: 428–436. 1938.

(4) SEMP, J., BAUMANN, C. A., AND STEENBOCK, H. The Carotene and Vitamin A. Content of Colostrum. Jour. Biol. Chem., 107: 697–703. 1934.

(5) HENRY, K. N., HOUSTON, J., AND KON, S. K. The Vitamin A and Carotene Content of Shorthorn Colostrum. Jour. Dairy Res., 11: 1–14. 1940.

(6) FRENCH, M. H. East African Agr. Jour., 8: 174. 1943.

(7) SUTTON, T. S., AND KAESER, H. E. Some Physiological Effects of Extending the Colostrum Feeding Period of Dairy Calves. JOUR. DAIRY SCI., 29: 13–26. 1946.

(8) HART, E. B., MCCOLLUM, E. V., STEENBOCK, H., AND HUMPHREY, G. C. Wis. Agr. Expt. Sta. Res. Bul. 17. 1911.

(9) JONES, I. R., ECKLES, C. H., AND PALMER, L. S. The Role of Vitamin A in the Nutrition of Calves. JOUR. DAIRY SCI., 9: 119–139. 1926.

(10) KRAUSS, W. E., MONROE, C. F., AND HAYDEN, C. C. Ohio Agr. Expt. Sta. Spec. Cir. 57. 1939.

(11) PHILLIPS, P. H., LUNDQUIST, N. S., AND BOYER, P. D. The Effect of Vitamin A and Certain Members of the B-Complex Upon Calf Scours. JOUR. DAIRY SCI., 24: 977–982. 1941.

(12) SUTTON, T. S., AND SOLDNER, P. A. The Effect of Parturition and Beginning Lactation on the Level of Carotene and Vitamin A in the Blood Plasma of Dairy Cows. JOUR. DAIRY SCI., 26: 740. 1943.

(13) BOYER, P. D., SPITZER, R., JENSEN, C., AND PHILLIPS, P. H. Determination of Vitamin A and Carotene in Milk. Indus. and Engin. Chem. (Analyt. Ed.), 16: 101–102. 1944.

(14) BERRY, M. H., AND MOORE, L. A. Effect of Colostrum on the Vitamin A and Carotene Content of Blood Plasma of New Born Calves. JOUR. DAIRY SCI., 27: 867–873. 1944.

(15) HANSEN, R. G., PHILLIPS, P. H., AND RUPEL, I. W. The Effect of Vitamin Supplements Upon Survival of New-Born Calves. In press.

# THE EFFECT OF CERTAIN COAL-TAR DYES USED FOR SEMEN IDENTIFICATION ON THE LIVABILITY AND FERTILITY OF BULL SPERMATOZOA*

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In the routine use of artificial breeding of dairy cattle it is impossible to distinguish the semen of one breed from that of another by any characteristic exhibited by the semen itself. Thus, in the handling of diluted semen of the various breeds, semen of one breed might inadvertently be used to inseminate cows of a different breed. Such mistakes are particularly serious in purebred herds where the registration of offspring is involved.

Recently Phillips (2) has reported data on the effect of certain vital dyes upon the motility of bull spermatozoa. He found that the addition of Nile blue sulfate, neutral red and Sudan III in sufficient amounts to distinctly color the diluent caused no marked harmful effects on spermatozoan motility over a storage period of several days. However, he stated that Sudan III was an inferior coloring agent due to its insolubility in water. Methylene blue, Janus green, thionin and alizarin sulphonate dyes reduced the motility of the spermatozoa to the extent that they could not be recommended for coloring purposes. No field data on the fertility of semen colored with vital dyes have been reported.

Since coal-tar dyes used for coloring foods for human consumption must be uniformly free from harmful impurities, studies were undertaken to determine whether certain of them could be used to color diluted semen. Laboratory and field studies were made to test their effects on the livability and fertility of bull spermatozoa.

## EXPERIMENTAL

Preliminary studies indicated that coal-tar dyes certified for general use in foods, drugs, and cosmetics (FD&C colors) offered a simple means of coloring semen under field conditions. These dye preparations can be obtained commercially in liquid form.[1] Since semen diluted with an egg yolk-buffer is yellow in color, it was necessary to resort to the use of shades or tints. The following certified FD&C liquid colors were found to give adequate color differentiation when added to diluted semen; (1) Strawberry Shade Red Color (pure dye content not less than 5.2%), (2) Emerald Shade Green Color (pure dye content not less than 2.7%), (3) Purple Shade Grape

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[1] Supplied through the courtesy of the Warner-Jenkinson Manufacturing Company, 2526 Baldwin Street, St. Louis 6, Missouri.

Color (pure dye content not less than 4.1%), and (4) Brown Color (pure dye content not less than 3.7%). These liquid colors contain two or more of the certified dyes commonly known as Amaranth, Ponceau SX, Ponceau 3R, Tartrazine, Fast Green FCF and Brilliant Blue FCF. The brown color also contains a substantial amount of caramel (burnt sugar color).

The dry dyes used in preparing the colors mentioned above are manufactured according to Federal specifications covering identity and purity, and each batch is individually certified by the Federal Food and Drug Administration. The liquid colors used in these studies are water solutions of the various certified FD&C dry colors and contain as a preservative, to prevent mold growths, 1/10 of 1 per cent sodium benzoate and enough food grade phosphoric acid to lower the pH to approximately 3.7. These liquid colors are additionally certified after preparation, as required by Federal regulations concerning the manufacture of such colors made for use in food products.

The above certified liquid colors are standardized as to strength, are uniform as to color intensity and can be stored for reasonably long periods of time. Since aqueous solutions made from certified dry FD&C colors must be used soon after preparation, unless a suitable preservative has been added, they are not as satisfactory for practical purposes as certified liquid FD&C colors which store well and require no further preparation before use.

*Livability during storage.* To determine the influence of these coal-tar dyes on the livability of spermatozoa under laboratory conditions, 15 fresh semen samples diluted at the rate of one part of semen to 10 parts of an egg yolk-citrate diluter (4) were colored, using one drop of dye solution for each 10 ml. of diluter. The diluted semen was gradually cooled to the storage temperature, 40° F., and the percentages of actively motile spermatozoa were determined every 2 days for a period of 10 days.

The 15 individual ejaculates had a mean concentration of 1,099 thousand spermatozoa per cubic mm., and a mean methylene blue reduction time (1) of 7.6 minutes.

The results of the motility observations are shown in table 1. Each figure represents a mean of fifteen ejaculates. Analysis of variance (5) of the motility data (table 1) involving 375 separate motility observations showed no significant differences between dyes. Highly significant differences ($P = < 0.01$) between ejaculates and between storage intervals were found, as well as a highly significant storage interval × ejaculate interaction.

*Field study of fertility.* After the foregoing experiments upon spermatozoan livability were completed, a study was conducted to determine the effects of these color preparations upon the fertility of semen used under routine artificial breeding conditions. The Latin square experimental design was employed in order to avoid bias in the selection of semen samples to be used with any particular dye, and to eliminate in so far as possible

TABLE 1

*The effect of certain coal-tar dyes on the livability of spermatozoa during storage*

| Treatment | Per cent motile spermatozoa (15 ejaculates) | | | | | |
|---|---|---|---|---|---|---|
| | Before storage | After storage at 40° F. for | | | | |
| | | 2 days | 4 days | 6 days | 8 days | 10 days |
| Control | 68 | 63 | 49 | 40 | 30 | 23 |
| Red | 68 | 61 | 48 | 39 | 29 | 21 |
| Green | 68 | 60 | 49 | 39 | 30 | 22 |
| Brown | 68 | 62 | 47 | 38 | 31 | 24 |
| Purple | 68 | 61 | 48 | 39 | 31 | 23 |

any inherent differences in fertility between the bulls, as well as any time trends in the fertility of the bulls (3). A 5×5 Latin square composed of 3 Holstein and 2 Guernsey bulls of the Nepa Artificial Breeding Cooperative, Tunkhannock, Pa.,[2] and five treatments, including the uncolored control and the red, green, brown, and purple color preparations was used. The first experiment (I), involving 5 one-week collection periods, was conducted from December 9, 1945, to January 12, 1946, and was immediately followed by the second (II) or replicate experiment which ran from January 13 to February 16, 1946. Thus the design called for 25 collections in each Latin square, or a total of 50 for the study. Therefore, 10 collections were used with each color treatment.

Whenever possible, only one semen ejaculate was collected from each bull during each weekly collection period. However, if the volume or quality of the first sample collected did not meet the requirements of the Cooperative for breeding purposes, a second ejaculate was collected and either used to replace the first ejaculate or mixed with it before dilution and the mixture considered as one sample in the experiment.

Following collection of the semen, data on the initial motility of the spermatozoa, the number of spermatozoa per cubic mm., and the methylene blue reduction time were obtained. Next the semen was diluted with egg

TABLE 2

*Mean data on the quality and dilution rate of the semen used in the field study*

| | Treatment | | | | |
|---|---|---|---|---|---|
| | Control | Red | Green | Brown | Purple |
| Sperm/mm.³ (thousands) | 1,538 | 1,541 | 1,738 | 1,640 | 1,496 |
| Motility (%) | 78 | 76 | 77 | 77 | 76 |
| Methylene blue reduction test (minutes) | 4.4 | 4.2 | 4.4 | 4.5 | 4.7 |
| Motility survival (days) | 23 | 22 | 25 | 21 | 22 |
| Ratio of semen to diluter | 1:17 | 1:17 | 1:18 | 1:16 | 1:17 |

[2] The author wishes to express his appreciation to William F. Schaefer, Jr., Manager, for carrying out the details of the field trial.

TABLE 3

*The effect of certain coal-tar dyes on the fertility of semen*

| Experiment | Treatment | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Control | | | Red | | | Green | | | Brown | | | Purple | | |
| | S | NR | % | S | NR | % | S | NR | % | S | NR | % | S | NR | % |
| I | 316 | 229 | 72.5 | 286 | 196 | 68.5 | 269 | 197 | 73.2 | 281 | 206 | 73.3 | 281 | 196 | 69.8 |
| II | 344 | 238 | 69.2 | 311 | 216 | 69.5 | 289 | 214 | 74.0 | 292 | 208 | 71.2 | 326 | 218 | 66.9 |
| Total | 660 | 467 | 70.8 | 597 | 412 | 69.0 | 558 | 411 | 73.7 | 573 | 414 | 72.3 | 607 | 414 | 68.2 |

S = Total of 1st and 2nd services.
NR = Total 2 months' non-returns.
% = Percentage of 2 months' non-returns.

yolk-citrate prepared according to the design of the experiment, and gradually cooled to 40° F. The diluted semen was utilized by two technicians operating out of the headquarters of the central organization, as well as shipped to six affiliated local artificial breeding cooperatives. From 1.0 to 1.5 ml. of diluted semen were used per insemination and the semen was usually deposited in the uterus.

The mean data on the quality and dilution rate of the semen used in this study are shown in table 2. Each figure is a mean of 10 ejaculates. The average rate of dilution was 1 : 17, with a range of from 1 : 11 up to 1 : 24.

In the livability study a higher concentration of dye solution than needed for satisfactorily coloring the semen was used. In the field trial only enough of the four coal-tar dyes tested was used to give adequate color distinctions. Thus one drop of the red, green, and brown color preparations was added for each 25 ml. of egg yolk-citrate diluter or major fraction thereof (or 0.2 ml. of dye solution per 100 ml. of diluter) while one drop of the purple shade was added for each 15 ml. of diluter.

Table 3 presents mean data on the fertility of dyed and undyed semen used for insemination purposes. A total of 2,995 inseminations, of which 2,376 were first services and 619 were second services, were involved in this study. An average of 59.9 first and second service cows were inseminated with each diluted semen sample. The smallest number of cows inseminated with any one sample was 12, while the highest was 107. In only 4 cases out of the possible 50 were the number of cows inseminated less than 25.

Analysis of variance of the fertility data (table 3) based on the percentages of first and second service cows which did not return for service within 60 days showed no significant differences in the fertility of the colored and uncolored semen samples. The highly significant difference ($P = < 0.01$) found between bulls was expected since bulls of different fertility levels were selected for the study.

## DISCUSSION

The experiments presented in this paper demonstrate that certain coal-tar dyes may be used as a practical means of coloring diluted bull semen. When the red, green, brown, and purple shade dye solutions were added to diluted semen there was no significant reduction in the ability of the spermatozoa to maintain their motility during storage.

Since a field trial would serve as a more conclusive means of testing the usefulness of these dyes, a study was designed using only enough of the several dye solutions to give adequate color differences. On the basis of 2,995 inseminations, or an average of 59.9 cows inseminated per sample of diluted semen, no significant differences between treatments were found.

Upon completion of the field trial the technicians were asked to give their reactions concerning the use of the particular dyes tested. Reports received

agreed that the red and green dye solutions gave the best color differentiation, while purple was the next most desirable. Brown was the least popular color. Since the completion of this experiment, the Nepa Artificial Breeding Cooperative has been routinely coloring all diluted Holstein semen green and all Jersey semen red, while Guernsey semen remained undyed or yellow owing to the presence of egg yolk in the diluter used. Ayrshire semen will be colored purple when bulls of that breed are added to the stud.

No practical difficulty has been experienced with fading of the coal-tar colors when added to diluted semen. Recently a sample of green vegetable color was obtained in liquid form from a commercial source. When added to diluted semen, it was observed that even though a distinct green color was imparted to the semen initially, the color faded very rapidly, whereas the colors obtained with semen treated with coal-tar dyes remained very stable.

## SUMMARY

Experiments were conducted to determine whether certified coal-tar dye solutions could be used to color diluted semen in order to reduce errors in its handling. Red, green, brown, and purple color preparations were tested under laboratory and field conditions. Spermatozoa in diluted semen colored at the rate of one drop of the basic red, green, brown, and purple dye solutions for each 10 ml. of diluter maintained their motility as well as those in the uncolored controls.

In a field study, when the same dyes were used at a lower concentration, no significant differences in fertility were found between the colored and uncolored semen samples. This investigation involved 2,995 inseminations and an average of 59.9 cows were inseminated per semen sample.

The results obtained demonstrate that the coal-tar color preparations described can be safely used as a practical means of coloring diluted bull semen.

## REFERENCES

(1) Beck, G. H., and Salisbury, G. W. Rapid Methods for Estimating the Quality of Bull Semen. Jour. Dairy Sci., 26: 483–494. 1943.

(2) Phillips, Paul H. A Practical Method of Coloring Semen for Identification Purposes. Jour. Dairy Sci., 28: 843–844. 1945.

(3) Salisbury, G. W., Elliott, Irvine, and Van Demark, N. L. Further Studies of the Effect of Dilution Rate on the Fertility of Bull Semen Used for Artificial Insemination. Jour. Dairy Sci., 28: 233–241. 1945.

(4) Salisbury, G. W., Fuller, H. K., and Willett, E. L. Preservation of Bovine Spermatozoa in Yolk-Citrate Diluent and Field Results from Its Use. Jour. Dairy Sci., 24: 905–910. 1941.

(5) Snedecor, G. W. Statistical Methods. 4th Edition. Collegiate Press, Inc., Ames, Iowa. 1946.

# INFLUENCE OF NONFAT DRY MILK SOLIDS ON THE NUTRITIVE VALUE OF BREAD

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Wheat flour is a good food and an excellent source of energy, which is one of the first requirements that must be adequately met in a diet, and since white bread may contribute an appreciable proportion of the required calories to the American dietary, considerable effort has been expended toward improving its nutritive value. Modifications of standard milling processes so as to retain more of the nutritive value of whole wheat (particularly in Canada and the British Isles); the addition of nonfat dry milk solids; the use of yeast products having a high vitamin potency, and more recently enrichment, are all measures which have been suggested to improve the nutritive value of white bread. The use of nonfat dry milk solids has had wide acceptance because in addition to improving the nutritive qualities of white bread it also improves the physical properties.

Fairbanks (1, 2) first demonstrated the value of nonfat dry milk solids in improving the nutritive value of white water bread. His results have recently been confirmed by Mitchell, Hamilton, and Shields (9) and Light and Frey (8). Henry, Houston, Kon, Powell, Carter, and Halton (7) have attributed the better nutritive value of white bread made with nonfat dry milk solids to an increase in quantity and quality of protein and increased amounts of calcium, riboflavin, and possibly other members of the $B_2$ complex. Harris, Clark, and Lockhart (6) and Volz, Forbes, Nelson, and Loosli (11) found that milk solids and soybean flour and combinations of these two supplements improve the nutritive value of white bread protein.

The studies here reported were undertaken for the purpose of making comparisons of the nutritive values of several types of bread largely used in this country, viz.: water bread, enriched water bread and two whole wheat breads which differed considerably in composition on account of the flour from which each was made. Each of these types of bread was studied with and without the addition of 6 per cent nonfat dry milk solids. Mitchell *et al.* (9) studied white bread enriched according to the standards proposed in 1941 (Federal Register (3)). Since that time new enrichment standards have been promulgated (Federal Register (4, 5)) and it seemed important to conduct studies at the new enrichment levels.

## METHODS

Young rats of the Sprague-Dawley strain weighing 35 to 50 grams were used in these studies. They were housed in individual cages and weighed

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twice weekly. Weighed portions of air-dried bread crumbs, mixed with water so as to prevent scattering, were fed daily. The bread crumbs, water, and a daily dose of 0.1 cc. USP cod-liver oil constituted the sole articles of diet throughout the 8-week test period. *Ad libitum* feeding was employed in Experiments No. 1 and No. 2. In Experiments No. 3 and No. 4 the animals were pair fed for equal gains.

Hemoglobin determinations were made on a Hellige clinical model hemoglobinometer using a sample of blood taken from the tip of the rat's tail. The values reported represent the average of duplicate determinations. A.O.A.C. (10) analytical methods for bread were used in determining the chemical composition of the diets and recognized chemical and microbiological methods were used in determining the amounts of iron and vitamins. The carcasses were prepared and analyzed in the following manner: At the end of the eight-week growth test the animals were killed, the intestinal contents removed, and the entire carcasses were quickly frozen. The frozen carcasses were ground three times with a food chopper, being adequately mixed and refrozen after each grinding. Appropriate aliquots of the entire ground carcasses were taken for chemical analyses following the methods for meat given in the A.O.A.C. (10).

### DESCRIPTION OF BREAD SAMPLES

Usually enough bread was baked at one time to last throughout each experiment. The breads were prepared using the following formula which is much like a commercial baker's formula. Sponge: 58 per cent flour, 2 per cent yeast, 0.5 per cent bread improver and 41.6 per cent water. Dough: 42 per cent flour, 4 per cent sugar, 2 per cent salt, 2 per cent malt, 1.5 per cent shortening (hydrogenated vegetable oil) and 27.7 per cent water. The same lot of white flour (0.42 per cent ash) or whole wheat flour was used to prepare all the breads fed in any one experiment; the supplements being added at the time the bread was made.

The following types of bread were studied.

1. *Water bread.* White flour without supplement.

2. *Enriched water bread.* White flour enriched to 10 per cent above the minimum levels for thiamine, riboflavin, niacin, and iron as specified in the new standards for enriched flour (Federal Register (4)). Analyses of the bread crumbs (table 1) show that these amounts of enrichment ingredients produced bread enriched well above the new minimum requirements of 1.1 mg. thiamine, 0.7 mg. riboflavin, 10 mg. niacin and 8 mg. of iron per pound of enriched bread (Fderal Register (5)).

3. *Nonfat milk bread.* 6 per cent nonfat dry milk solids based upon weight of white flour.

4. *Enriched nonfat milk bread.* A combination of the supplements given under 2 and 3.

5. *Whole wheat bread.* 100 per cent whole wheat flour.

6. *Whole wheat nonfat milk bread.* 6 per cent nonfat dry milk solids based upon weight of whole wheat flour.

Two different lots of whole wheat flour were used and the breads made from them showed differences in chemical composition as shown in table 1. For example, whole wheat bread #1 contained 17.13 per cent protein whereas whole wheat bread #2 contained 15.14 per cent protein.

Complete chemical and vitamin analyses were not made on all the bread samples fed. However, the same formula was followed wherever confirmatory tests were made and the analyses of each type of bread studied is shown in table 1. Every lot of bread was tested for moisture and protein. The analyses of the bread crumbs have been calculated to the basis of fresh bread containing 38 per cent moisture and these values are also shown in table 1.

## RESULTS OF FEEDING EXPERIMENTS

The results from the feeding experiments are summarized in table 2. The relative nutritive values of these several types of bread can be fairly accurately evaluated on the basis of the grams of solids required to produce one gram of gain and this has been done as shown in the last column of table 2. When evaluated on this basis the smaller the weight of food required to produce a gram of gain, the higher the nutritive value of the food. The nutritive values calculated in this manner were subjected to statistical analysis in order to determine the significance of differences referred to in this report.

*Experiments No. 1 and No. 2 (ad libitum feeding).* The small differences between the nutritive values of water bread and enriched water bread are not significant when the data are analyzed by Student's "t" test for unpaired differences. (Experiment No. 1, $P > 0.9$; Experiment No. 2, $P = 0.4$).[1]

The addition of 6 per cent nonfat dry milk solids greatly improved the nutritive value of enriched water bread in both experiments, and the results from Experiment No. 2 indicate that water bread containing 6 per cent nonfat dry milk solids is equal in nutritive value to enriched water bread containing 6 per cent nonfat dry milk solids. Mitchell *et al.* (9) obtained similar results; however, they observed a slight but significant increase in hemoglobin levels when nonfat milk bread was enriched according to the 1941 standards. Hemoglobin determinations were not made on the animals used for this comparison in these studies.

[1] The numerical value of $P$ (Probability) indicates whether the difference between observed values are due to chance or to the imposed experimental conditions. When $P \leq 0.05$ (odds $\geq 19:1$) we consider the difference between two means to be statistically significant. When $P \leq 0.01$ (odds $\geq 99:1$) we consider the difference to be highly significant.

TABLE 1

*Typical analyses of breads used in feeding trials*

| Identification | Moisture | Protein (N × 6.25) | Ash | Calcium | Phosphorus | Iron per lb. | Thiamine per lb. | Riboflavin per lb. | Niacin per lb. |
|---|---|---|---|---|---|---|---|---|---|
| **Composition of dry bread crumbs** | | | | | | | | | |
| | % | % | % | % | % | *mg.* | *mg.* | *mg.* | *mg.* |
| Enriched water bread | 6.78 | 12.95 | 2.60 | 0.060 | 0.098 | 12.20 | 1.86 | 1.36 | 15.62 |
| Enriched nonfat milk bread | 7.15 | 14.25 | 2.87 | 0.120 | 0.139 | 12.00 | 1.80 | 1.86 | 15.57 |
| Water bread | 7.57 | 12.96 | 2.54 | 0.055 | 0.096 | 5.45 | 0.50 | 0.38 | 4.31 |
| Nonfat milk bread | 9.22 | 13.38 | 3.00 | 0.114 | 0.136 | 11.32 | 0.43 | 1.23 | 4.80 |
| Whole wheat bread #1 | 10.45 | 17.13 | 3.39 | 0.065 | 0.234 | 22.60 | 1.36 | 1.27 | 18.06 |
| Whole wheat nonfat milk bread #1 | 10.42 | 17.45 | 3.74 | 0.132 | 0.247 | 24.00 | 1.09 | 2.50 | 17.45 |
| Whole wheat bread #2 | 10.75 | 15.14 | 3.34 | 0.070 | 0.415 | 17.60 | 1.75 | 0.80 | 17.80 |
| Whole wheat nonfat milk bread #2 | 11.01 | 16.24 | 3.53 | 0.140 | 0.475 | 15.70 | 1.20 | 2.47 | 15.30 |
| **Composition of bread (38% moisture) calculated from crumb analyses** | | | | | | | | | |
| | % | % | % | % | % | *mg.* | *mg.* | *mg.* | *mg.* |
| Enriched water bread | 38.0 | 8.61 | 1.73 | 0.040 | 0.065 | 8.11 | 1.24 | 0.90 | 10.39 |
| Enriched nonfat milk bread | 38.0 | 9.52 | 1.92 | 0.080 | 0.093 | 8.01 | 1.20 | 1.24 | 10.40 |
| Water bread | 38.0 | 8.69 | 1.70 | 0.037 | 0.064 | 3.66 | 0.34 | 0.25 | 2.89 |
| Nonfat milk bread | 38.0 | 9.14 | 2.05 | 0.078 | 0.093 | 7.73 | 0.29 | 0.84 | 3.27 |
| Whole wheat bread #1 | 38.0 | 11.86 | 2.35 | 0.045 | 0.162 | 15.64 | 0.94 | 0.88 | 12.50 |
| Whole wheat nonfat milk bread #1 | 38.0 | 12.08 | 2.59 | 0.091 | 0.171 | 16.61 | 0.75 | 1.73 | 12.08 |
| Whole wheat bread #2 | 38.0 | 10.52 | 2.32 | 0.049 | 0.288 | 12.22 | 1.22 | 0.56 | 12.36 |
| Whole wheat nonfat milk bread #2 | 38.0 | 11.31 | 2.46 | 0.098 | 0.331 | 10.95 | 0.84 | 1.72 | 10.66 |

Nonfat milk bread was not equal in nutritive value to whole wheat bread #1. Also the addition of 6 per cent nonfat dry milk solids did not produce a significant improvement ($P = 0.12$) in the nutritive value of whole wheat

TABLE 2

*Summarized data from feeding tests*

| Diet | No. of rats | Av. initial weight | Av. wt. at end of 8 weeks | Av. gain | Av. wt. bread solids consumed | Bread solids required for one gram gain |
|---|---|---|---|---|---|---|
| Experiment No. 1 (*ad libitum* feeding) | | | | | | |
| | | *gm.* | *gm.* | *gm.* | *gm.* | *gm.* |
| Enriched water bread | 8 | 42.4 | 85.5 | 43.1 | 312.9 | 7.34 |
| Water bread | 8 | 43.0 | 90.6 | 47.6 | 340.7 | 7.25 |
| Enriched nonfat milk bread | 8 | 40.9 | 132.0 | 91.1 | 442.4 | 4.90 |
| Experiment No. 2 (*ad libitum* feeding) | | | | | | |
| | | *gm.* | *gm.* | *gm.* | *gm.* | *gm.* |
| Enriched water bread | 8 | 41.0 | 79.2 | 38.4 | 296.8 | 7.85 |
| Water bread | 8 | 39.6 | 73.6 | 34.0 | 275.4 | 8.28 |
| Enriched nonfat milk bread | 8 | 40.5 | 100.5 | 60.2 | 367.6 | 6.15 |
| Nonfat milk bread | 8 | 39.0 | 98.0 | 59.0 | 355.6 | 6.10 |
| Whole wheat bread #1 | 8 | 40.0 | 154.1 | 114.2 | 527.0 | 4.66 |
| Whole wheat nonfat milk bread #1 | 8 | 41.5 | 192.6 | 151.1 | 638.8 | 4.30 |
| Experiment No. 3 (paired feeding for equal gain) | | | | | | |
| | | *gm.* | *gm.* | *gm.* | *gm.* | *gm.* |
| Enriched water bread | 12 | 40.5 | 65.3 | 27.4 | 261.1 | 10.75 |
| Water bread | 12 | 40.4 | 63.8 | 22.6 | 269.1 | 12.10 |
| Nonfat milk bread | 12 | 38.3 | 80.7 | 42.3 | 279.8 | 6.61 |
| Enriched water bread | 12 | 38.8 | 76.5 | 37.7 | 333.9 | 8.86 |
| Whole wheat nonfat milk bread #1 | 12 | 39.4 | 135.1 | 95.6 | 434.6 | 4.57 |
| Whole wheat bread #1 | 12 | 39.0 | 130.6 | 91.6 | 486.6 | 5.35 |
| Nonfat milk bread | 12 | 38.3 | 101.4 | 63.2 | 380.3 | 6.13 |
| Whole wheat bread #1 | 12 | 37.4 | 103.7 | 66.3 | 348.8 | 5.28 |
| Experiment No. 4 (paired feeding for equal gain) | | | | | | |
| | | *gm.* | *gm.* | *gm.* | *gm.* | *gm.* |
| Enriched nonfat milk bread | 8 | 39.6 | 97.9 | 58.3 | 335.9 | 5.85 |
| Whole wheat bread #2 | 8 | 40.5 | 100.6 | 60.1 | 334.3 | 5.62 |
| Whole wheat bread #2 | 8 | 37.9 | 103.0 | 65.1 | 360.7 | 5.57 |
| Whole wheat nonfat milk bread #2 | 8 | 38.5 | 104.8 | 66.3 | 332.1 | 5.02 |

bread #1. It should be noted that whole wheat bread #2 which was fed in Experiment No. 4 had a lower nutritive value.

*Experiment No. 3 (paired feeding for equal gain).* Since Experiment

No. 1 and Experiment No. 2 were conducted by the *ad libitum* feeding method, differences in the palatability of the several types of bread may have influenced the results. Also, some of the animals attained greater body weights than others and thus required a larger amount of energy for maintenance. Therefore, a number of these breads were fed in Experiment No. 3 wherein comparisons between two types of bread were made by feeding them to 12 pairs of rats for equal gains. As is indicated by the grouping of the summarized feeding test data from this experiment in table 2 the following comparisons were made:

1. Enriched water bread versus water bread.
2. Nonfat milk bread versus enriched water bread.
3. Whole wheat nonfat milk bread #1 versus whole wheat bread #1.
4. Nonfat milk bread versus whole wheat bread #1.

When compared by this method and the data analyzed by Student's "t" test for paired differences, enriched water bread exhibited a nutritive value which was significantly higher than that of water bread ($P < 0.01$). Whereas we have been able to demonstrate a slight improvement in the nutritive value of water bread by enrichment to the new levels it should be noted that neither of these two types of bread has as high nutritive value as are exhibited by the other types of bread fed in these experiments.

The results on nonfat milk bread and enriched water bread are in agreement with those obtained in Experiments No. 1 and No. 2, and again show the superior nutritive value of water bread made with 6 per cent nonfat dry milk solids.

When fed for equal gains the addition of 6 per cent nonfat dry milk solids produced a significant improvement in the nutritive value of whole wheat bread #1 ($P < 0.01$). However, this lot of whole wheat bread still exhibited a higher nutritive value than nonfat milk bread ($P < 0.01$).

*Experiment No. 4 (paired feeding for equal gain).* It appeared that we had been using a whole wheat flour of unusually high nutritive value in Experiments No. 2 and No. 3. The whole wheat bread crumbs had a very high protein content (17.13%) and the results from the feeding tests did not agree with similar experiments reported in the literature (Mitchell *et al.* (9) and Light and Frey (8)). Therefore we repeated the experiments involving whole wheat bread using a whole wheat flour of lower protein content or one which more closely approached the average protein content of whole wheat flour. The breads made from this flour are referred to as whole wheat bread #2.

The results of this feeding test are also shown in table 2. The difference between the nutritive value of enriched nonfat milk bread and whole wheat bread #2 was not significant ($P > 0.1$) and the nutritive value of whole wheat bread #2 was improved by the addition of 6 per cent nonfat dry milk solids ($P < 0.01$).

### CARCASS ANALYSES

Rate of growth on a diet and the nutritive value of the diet as measured by the grams of solids required to produce a gram of grain are generally recognized methods of evaluating a diet. However, further information about the nutritive value of a diet can be obtained from the chemical composition of the deposited tissue since this can vary in percentage of solids, fat, ash and protein. In order to evaluate some of the bread diets from this standpoint a number of the carcasses from experiments No. 3 and No. 4 were analyzed. Since the animals were pair fed for equal gain the analytical data were analyzed statistically by Student's "t" test for paired differences.

*Experiment No. 3.* The 12 pairs of rats which had been fed for equal gains on nonfat milk bread and enriched water bread were continued on the same dietary regime for two weeks following the 8 week growth test during which time hemoglobin determinations were made. The hemoglobin values, weights of the cleaned carcasses and results of the chemical analyses of the carcasses are summarized in table 3.

TABLE 3

*Average hemoglobin values and carcass analyses—Experiment No. 3*

| Diet | Av. weight of cleaned carcass | Av. hemoglobin | Carcass analyses | | |
|---|---|---|---|---|---|
| | | | Ash | Calcium | Nitrogen |
| | *gm.* | *gm./100 cc.* | % | % | % |
| Enriched water bread | 88.7 | 13.27 | 2.79 | 0.68 | 3.070 |
| Nonfat milk bread | 92.2 | 12.96 | 3.35 | 0.88 | 3.172 |

The carcasses of the nonfat milk bread rats contained a significantly higher percentage of nitrogen ($P = 0.02$) and a significantly higher percentage of calcium ($P < 0.01$). The difference between the concentration of hemoglobin in the blood of the two groups of rats was not significant ($P = 0.3$). Fairbanks (2) showed that the addition of 6 per cent nonfat dry milk solids to white water bread increased the calcium content but not the nitrogen content of the carcass.

*Experiment No. 4.* The four groups of 8 rats each used in this paired feeding experiment were killed immediately following the 8-week growth test and the prepared carcasses were analyzed for total solids, fat, protein, and ash. The weights of the cleaned carcasses and their average chemical composition calculated to the dry basis are summarized in table 4.

The carcasses of the animals which had been fed enriched nonfat milk bread contained a significantly higher percentage of ash than the carcasses of the animals which had been fed whole wheat bread #2 ($P < 0.01$). Other

TABLE 4

*Average carcass analyses—Experiment No. 4*

| Diet | Av. weight of cleaned carcass | Solids | Fat dry basis | Ash dry basis | Crude protein (N × 6.25) dry basis |
|---|---|---|---|---|---|
| | *gm.* | % | % | % | % |
| Enriched nonfat milk bread | 94.0 | 34.10 | 32.94 | 9.79 | 56.96 |
| Whole wheat bread #2 | 96.4 | 33.43 | 32.08 | 7.96 | 59.93 |
| Whole wheat bread #2 | 99.5 | 33.78 | 33.72 | 7.65 | 57.96 |
| Whole wheat nonfat milk bread #2 | 101.5 | 33.04 | 30.04 | 9.33 | 59.96 |

differences in the chemical composition of the carcasses of these two groups of experimental animals were not statistically significant. Therefore, it appears that enriched nonfat milk bread is equivalent in nutritive value to whole wheat bread of average composition both from the standpoint of weight gained per unit of bread solids consumed and from the chemical composition of the carcass produced. Judged on the basis of per cent ash in the carcasses, enriched nonfat milk bread seems to be nutritionally superior to whole wheat bread. Mitchell *et al.* (9) found that white bread made with 6 per cent nonfat milk solids was superior to whole wheat bread in the promotion of bone calcification.

The carcasses of the animals which had been fed whole wheat nonfat milk bread #2 contained a significantly higher percentage of ash than the carcasses of the animals which received whole wheat bread #2 ($P < 0.02$). Otherwise the differences in chemical composition between these two lots of carcasses were not statistically significant. These results confirm those of the growth experiment wherein whole wheat nonfat milk bread was found to have a higher nutritive value than whole wheat bread. It required less of the whole wheat nonfat milk bread to produce a one-gram gain, yet the carcass composition was equivalent to that of those fed the whole wheat bread in solids, fat and protein, and superior to those of the rats fed whole wheat bread in ash.

## CONCLUSIONS

1. The addition of 6 per cent nonfat dry milk solids improves the nutritive value of water bread, enriched water bread and whole wheat bread.

2. Water bread supplemented with 6 per cent nonfat dry milk solids is superior in nutritive value to enriched water bread as measured by the grams of solids required to produce a gram of gain and the per cent nitrogen and calcium in the carcasses of the experimental animals. There was no significant difference between hemoglobin levels in the rats on which these comparisons were made.

3. Water bread supplemented with 6 per cent nonfat dry milk solids and enriched to the levels of the new standards is equivalent in nutritive

value to whole wheat bread of average composition as measured by grams of solids required to produce a one-gram gain and the chemical composition of the carcasses of the experimental animals.

4. Enrichment at the new levels causes a slight improvement in the nutritive value of water bread which can be observed by paired feeding for equal gain.

5. The improvement in the nutritive value of whole wheat bread brought about by the addition of 6 per cent nonfat dry milk solids has been confirmed by carcass analyses.

6. Whole wheat breads vary in nutritive value depending upon the type of whole wheat flour used.

## REFERENCES

(1) FAIRBANKS, B. W. Improving the Nutritive Value of Bread by the Addition of Dry Milk Solids. Cereal Chem., 15: 169–180. 1938.

(2) FAIRBANKS, B. W. A Study by the Paired Feeding Method of the Nutritive Value of Bread Made With Milk Solids. Cereal Chem., 16: 404–414. 1939.

(3) Federal Register, 6: 2771–2774. No. 111, June 7, 1941.

(4) Federal Register, 8: 9115–9116. No. 131, July 3, 1943.

(5) Federal Register, 8: 10780–10788. No. 152, Aug. 3, 1943.

(6) HARRIS, ROBERT S., CLARK, MARIE, AND LOCKHART, ERNEST E. Nutritional Value of Bread Containing Soya Flour and Milk Solids. Arch. Biochem., 4: 243–247. 1944.

(7) HENRY, K. M., HOUSTON, J., KON, S. K., POWELL, J., CARTER, R. H., AND HALTON, P. The Effects of Additions of Dried Skim Milk and Dried Whey on the Baking Quality and Nutritive Properties of White Bread. Jour. Dairy Res., 12: 184–212. 1941.

(8) LIGHT, ROBERT F., AND FREY, CHARLES N. The Nutritive Value of White and Whole Wheat Breads. Cereal Chem., 20: 645–660. 1943.

(9) MITCHELL, H. H., HAMILTON, T. S., AND SHIELDS, J. B. The Contribution of Nonfat Milk Solids to the Nutritive Value of Wheat Breads. Jour. Nutr., 25: 585–603. 1943.

(10) Official and Tentative Methods of Analysis of the Association of Official Agricultural Chemists, 5th edition, 1940.

(11) VOLZ, FRANCES E., FORBES, R. M., NELSON, W. L., AND LOOSLI, J. K. The Effect of Soy Flour on the Nutritive Value of the Protein of White Bread. Jour. Nutr., 29: 269–275. 1945.

# BLOOD STUDIES OF LOUISIANA DAIRY COWS. II. CALCIUM, INORGANIC PHOSPHORUS, HEMOGLOBIN VALUE, ERYTHROCYTE COUNT, LEUCOCYTE COUNT AND DIFFERENTIAL LEUCOCYTE PERCENTAGES

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Studies of animal blood have taken a prominent place in nutritional and physiological research. "Normal" blood values for dairy cattle have been published for calcium (1, 17, 25, 9, 22, 23), inorganic phosphorus (1, 15, 9, 12, 5, 24), hemoglobin (1, 13, 2, 14), and blood cells—erythrocyte count, leucocyte count and percentages of types of leucocytes (19, 4, 6). In general, there is a lack of agreement among the values reported for most of these constituents.

Many factors contribute to the differences in the average "normal" blood calcium and inorganic phosphorus values for dairy cattle. Among those factors can be listed types of methods and techniques such as using blood serum (1, 25, 5), blood plasma (15, 17, 9), or whole blood (12, 22, 24), dietary factors (16, 11, 22, 23), physiological factors (15, 24, 21, 22, 23), and many other factors, known and unknown (18, 15, 17, 10, 5).

Ferguson, Irwin, and Beach (6) found the variation in their study of the blood cells of healthy dairy cattle to be due particularly to differences between animals. They propose that "each animal of the species probably has a blood picture in health peculiar to itself, just as each has its own size, form, etc."

More accurate measurements are therefore necessary concerning the amount of variation for various blood constituents of dairy animals in different sections of the country.

This study was made to determine the variations in the blood picture over a period of time of high-producing dairy animals in two separate herds which were fed and managed better than the average. Also included is the blood picture of low-producing animals of an experimental herd on a basal diet which contained poor quality hay as the only source of roughage, supplemented with either calcium or phosphorus, or both calcium and phosphorus, or neither of these minerals.

## EXPERIMENTAL

Determinations were made over a period of approximately two years, beginning in March 1944, on pooled citrated blood drawn on three consecutive days either monthly or bi-monthly from 10 Holstein and 6 Jersey

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[1] Dairy Research and Veterinary Science Departments, respectively.

cows of the L.S.U. herd at Baton Rouge, from 8 to 16 Jersey cows of the U.S.D.A. experimental herd at Jeanerette, and 14 Jersey cows of the experimental herd at L.S.U. Six of the original 16 animals in the L.S.U. herd, 12 of the original 16 animals in the Jeanerette herd, and all of the animals in the experimental herd were used continuously during the 2-year period. The remaining animals of the original 16 in the L.S.U. and Jeanerette herds were replaced by other animals in the herd during the 2-year period. Only 8 of the 12 original animals in the Jeanerette herd were continuously used for hemoglobin and cell counts. Analyses for calcium and phosphorus were made on 773 pooled samples of blood, while 613 pooled blood samples were used for determinations of hemoglobin, erythrocyte count, leucocyte count, and differential leucocyte percentages.

Calcium was determined by the Clark-Collip modification of the Kramer-Tisdall method (3), phosphorus by the Fiske and Subbarow method (7) using a Coleman spectrophotometer, hemoglobin by the acid hematin method with a Klett-Summerson photoelectric colorimeter, standardized for 13.8 grams per 100 cc. of blood equal to 100 per cent. Total counts were made with standard hemocytometers and pipettes. Thick blood smears stained with Giemsa stain (8) were used for the differential counts of the various types of leucocytes.

A statistical analysis of the data was made according to Snedecor (20).

## RESULTS AND DISCUSSION

Table 1 presents the plasma calcium, plasma inorganic phosphorus, and hemoglobin values for 46 dairy animals in three separate herds over a period of two years.

*Calcium.* The plasma calcium values for the animals in the L.S.U. herd ranged from 9.00 to 15.28 mg. per cent with a mean of 10.89 ± 0.21; for the

TABLE 1

*The calcium, inorganic phosphorus, and hemoglobin values for Louisiana dairy cows over a 2-year period*

| Herd | No. of samples | Range | Mean S. E. |
|---|---|---|---|
| Calcium (mg. % plasma) | | | |
| L.S.U. | 213 | 9.00–15.28 | 10.89 ± 0.21 |
| Jeanerette | 320 | 9.35–13.87 | 11.36 ± 0.15 |
| Experimental | 240 | 7.22–12.73 | 9.95 |
| Phosphorus (mg. % plasma) | | | |
| L.S.U. | 213 | 4.00– 8.80 | 5.77 ± 0.13 |
| Jeanerette | 320 | 3.50– 9.00 | 5.02 ± 0.07 |
| Experimental | 240 | 3.07– 9.44 | 6.14 |
| Hemoglobin (gm./100 cc. whole blood) | | | |
| L.S.U. | 213 | 8.99–18.60 | 11.59 ± 0.36 |
| Jeanerette | 160 | 8.91–15.86 | 11.19 ± 0.27 |
| Experimental | 240 | 9.60–18.25 | 13.39 ± 0.22 |

Jeanerette herd the range was 9.35 to 13.87 mg. per cent with a mean of 11.36 ± 0.15; and for the experimental herd the range was 7.22 to 12.73 mg. per cent with a mean of 9.95 mg. per cent. Since some of the animals in the experimental herd were receiving experimental rations supplemented with calcium and/or phosphorus, the standard errors for the mean plasma calcium and mean inorganic phosphorus values were not determined.

Much variation was present for the values for plasma calcium. Using analysis of variance, it was found for plasma calcium values that significant differences[2] existed *between animals* in a herd, and highly significant differences[3] existed *between months* (within animals). Nonsignificant differences were found between the mean calcium values for the three herds; and between the calcium values for Holsteins and Jerseys; and for the values between seasons of the year for each of the herds.

The mean plasma calcium values found are within the ranges reported by Robinson and Huffman (18), Palmer and Eckles (17), and Haag and Jones (9) who used blood plasma, although our calcium values for the various herds range slightly wider and higher. The calcium values for the animals in the experimental herd which were fed poor quality hay as the only source of roughage, with calcium supplement for some of the animals, are slightly lower than those of the better-than-average-fed herds, but not significantly lower.

The calcium values reported for blood serum by Anderson and co-workers (1) for calves and cows range from 9.96 to 16.18 mg. per cent, with an average of 12.63 mg. per cent. The average value for 5 cows was 13.31 mg. per cent. Figures reported for whole blood by Van Landingham *et al.* (22) range from 6.31 to 7.78 mg. per cent with an average of 7.06 mg. per cent.

*Phosphorus.* The plasma inorganic phosphorus values for the animals in the L.S.U. herds ranged from 4.00 to 8.80 mg. per cent with a mean of 5.77 ± 0.13; for the Jeanerette herd the range was 3.50 to 9.00 mg. per cent with a mean of 5.03 ± 0.07; and for the experimental herd the range was 3.07 to 9.44 mg. per cent with a mean of 6.14.

Significant differences[2] existed *between animals* in a herd and highly significant differences[3] existed *between months* (within animals) for the plasma inorganic phosphorus values. Nonsignificant differences were found between the L.S.U. and Jeanerette herds for the mean inorganic phosphorus values. For the experimental herd the mean inorganic phosphorus value was higher than and significantly different from those of the other herds. Nonsignificant seasonal variations were found for the inorganic phosphorus values for each of the herds, or between Holstein and Jersey values.

It is generally believed by dairy nutritionists that 4 to 6 mg. of inorganic phosphorus per 100 cc. of blood plasma are the normal levels for cows

[2] $P = 0.05$.

[3] $P = 0.01$.

(21). The inorganic phosphorus values for the L.S.U. and Jeanerette herds, 3.50 to 9.00 mg. per cent range somewhat higher than those reported in the literature for blood plasma by Robinson and Huffman (18), Palmer, Cunningham, and Eckles (15), and Haag and Jones (9), but the mean values are similar. Averages for inorganic phosphorus in blood serum as published by Anderson *et al.* (1) and Eveleth *et al.* (5) range from 4.46 to

TABLE 2

*The erythrocyte count, leucocyte count and differential leucocyte percentages for Louisiana dairy cows over a 2-year period*

| Herd | No. of samples | Range | Mean S. E. |
|---|---|---|---|
| **Erythrocytes (million/cmm. whole blood)** | | | |
| L.S.U. | 213 | 2.57–9.94 | 5.27 ± 0.027 |
| Jeanerette | 160 | 3.00–7.48 | 4.89 ± 0.030 |
| Experimental | 240 | 3.03–9.60 | 5.72 ± 0.035 |
| **Leucocytes (per cmm. whole blood)** | | | |
| L.S.U. | 213 | 5,100–19,100 | 10,268 ± 45 |
| Jeanerette | 160 | 4,400–15,350 | 8,411 ± 31 |
| Experimental | 240 | 4,750–18,850 | 9,806 ± 20 |
| **Differential leucocytes** | | | |
| | | Lymphocytes (%) | |
| L.S.U. | 213 | 40–72 | 57.26 ± 0.79 |
| Jeanerette | 160 | 31–74 | 54.46 ± 0.86 |
| Experimental | 240 | 30–81 | 56.52 ± 0.74 |
| | | Neutrophiles (%) | |
| L.S.U. | 213 | 10–58 | 29.35 ± 0.65 |
| Jeanerette | 160 | 16–52 | 32.64 ± 0.87 |
| Experimental | 240 | 11–68 | 30.23 ± 0.72 |
| | | Eosinophiles (%) | |
| L.S.U. | 213 | 0–23 | 7.32 ± 0.37 |
| Jeanerette | 160 | 0–26 | 6.86 ± 0.37 |
| Experimental | 240 | 0–25 | 6.40 ± 0.38 |
| | | Monocytes (%) | |
| L.S.U. | 213 | 0–17 | 5.49 ± 0.06 |
| Jeanerette | 160 | 0–16 | 5.67 ± 0.05 |
| Experimental | 240 | 0–19 | 6.38 ± 0.04 |
| | | Basophiles (%) | |
| L.S.U. | 213 | 0–4 | 0.58 ± 0.08 |
| Jeanerette | 160 | 0–6 | 0.37 ± 0.09 |
| Experimental | 240 | 0–6 | 0.47 ± 0.06 |

8.02 mg. per cent, and in whole blood Johnson (12) and Van Landingham (24) report 4.3 mg. per cent for mature cows.

*Hemoglobin.* The hemoglobin values for the three herds ranged from 8.91 to 18.60 mg. per cent, and the mean values ranged from 11.19 ± 0.27 to 13.39 ± 0.22 mg. per cent. Significant differences were found *between months* (within animals in a herd) for hemoglobin content, and also between the herds on an intra-month basis. Only low and insignificant correlations were found between either calcium or inorganic phosphorus and the hemo-

globin values. Our values are within the range reported by other investigators (1, 13, 2, 14). Unless values are standardized on a percentage basis, they are difficult to compare since various methods use different standards.

*Blood cells.* Table 2 presents the number of erythrocytes and leucocytes, eosinophiles, monocytes, and basophiles for 38 dairy animals in three separate herds over a period of two years.

Significant differences *between animals* on an intra-herd basis were found only for the leucocyte count. Between-herd differences, however, were significant for erythrocyte count, leucocyte count, percentages of lymphocytes, neutrophiles and monocytes.

Only low and nonsignificant correlations were found between either calcium or inorganic phosphorus values and the erythrocyte or leucocyte counts.

Our erythrocyte counts are lower than values reported for purebred or grade Holstein cows and heifers by Ferguson, Irwin, and Beach (6) of Wisconsin who found a range of 4 to 10 million red blood cells per cubic millimeter with a mean of $6.33 \pm 0.018$ million, and 6.32 million red blood cells cited by Dukes (4). The mean leucocyte count for the animals of the L.S.U. herd and the experimental herd is higher than the value, $8{,}911 \pm 42$ reported by Ferguson *et al.* (6) and 7,900 cited by Dukes (4). No explanation as to why the erythrocyte counts are lower and the leucocyte counts higher in two of the herds can be given at this time. The mean percentages of lymphocytes, neutrophiles, and basophiles are between those cited by Ferguson *et al.* (6) and Dukes (4). The mean percentage of eosinophiles, 6.40 to 7.32 per cent, is slightly higher than the 5.0 per cent given by Dukes (4), but the $14.87 \pm 0.13$ per cent reported by Ferguson *et al.* (6) is twice as high as our figures, and almost three times as high as that cited by Dukes. The percentages of monocytes are slightly lower than the values reported (6, 4). According to Ferguson *et al.* (6), one explanation for the differences in percentages of types of leucocytes might be the staining technique used by the various investigators. They used the supravital staining method of Sabin (neutral red and Janus green); Dukes cited references that used Wright's stain; while in our study Giemsa stain was used.

Poor quality hay in the ration for the experimental herd did not seem to influence the amounts of the various cellular constituents.

Thus, differences in methods and technique employed, as well as physiological, environmental, and other factors are always present so that variations in "normal" values result. Isolated and single observations are sometimes used to reach certain conclusions, and are easily misinterpreted unless evaluated critically.

## SUMMARY

Variations in the blood picture of high-producing dairy animals in two separate herds which were fed and managed better than average are pre-

sented. Also included is the blood picture of low-producing animals of an experimental herd which were on a basal diet containing poor quality hay as the only source of roughage, supplemented with either calcium or phosphorus, both calcium and phosphorus, or neither of these minerals.

Analyses were made on pooled citrated blood drawn on three consecutive days from 38 to 46 animals either monthly or bi-monthly over a period of approximately two years.

A statistical analysis of 773 determinations for calcium and phosphorus and 613 observations for hemoglobin, erythrocyte count, leucocyte count, and differential leucocyte percentages was made. Using the analysis of variance it was found that significant differences existed *between animals* in a herd and *between months* (within animals) for calcium and phosphorus values. There were significant differences *between months* (within animals) in a herd for hemoglobin values, and *between animals* for the leucocyte count. No significant seasonal variations were found. Only low and nonsignificant correlations were found between either calcium or phosphorus and the hemoglobin value, erythrocyte, or leucocyte counts. Significant differences were found between herds for hemoglobin content, erythrocyte count, leucocyte count, percentages of lymphocytes, neutrophiles and monocytes.

Poor quality hay in the ration of the experimental herd did not seem to influence the blood calcium content or amounts of the various cellular constituents, but the phosphorus and hemoglobin values were significantly different from those of the other herds.

The range of means and their standard errors for the herds were as follows:

| | | | | |
|---|---|---|---|---|
| Calcium | $10.89 \pm 0.21$ | to | $11.36 \pm 0.15$ | mg. per cent plasma |
| Phosphorus | $5.02 \pm 0.07$ | to | $5.77 \pm 0.13$ | mg. per cent plasma |
| Hemoglobin | $11.19 \pm 0.27$ | to | $13.39 \pm 0.22$ | gm. per 100 cc. blood |
| Erythrocytes | $4.89 \pm 0.030$ | to | $5.72 \pm 0.035$ | millions per cmm. blood |
| Leucocytes | $8{,}411 \pm 31$ | to | $10{,}268 \pm 45$ | per cmm. blood |
| Lymphocytes | $54.46 \pm 0.86$ | to | $57.26 \pm 0.79$ | per cent |
| Neutrophiles | $29.35 \pm 0.65$ | to | $32.64 \pm 0.87$ | per cent |
| Eosinophiles | $6.40 \pm 0.38$ | to | $7.32 \pm 0.37$ | per cent |
| Monocytes | $5.49 \pm 0.06$ | to | $6.38 \pm 0.04$ | per cent |
| Basophiles | $0.37 \pm 0.09$ | to | $0.58 \pm 0.08$ | per cent |

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## REFERENCES


(1) Anderson, A. K., Galey, H. R., and Pratt, A. D. Studies on the Chemical Composition of Bovine Blood. Jour. Dairy Sci., **13**: 336–347. 1930.

(2) Brooks, H. J., and Hughes, J. S. The Hemoglobin Content of the Blood of Dairy Cattle. Jour. Nutr., **5**: 35–38. 1932.

(3) Clark, E. P., and Collip, J. B. A Study of the Tisdall Method for the Determination of Blood Serum Calcium with a Suggested Modification. Jour. Biol. Chem., **63**: 461–464. 1925.

(4) Dukes, H. H. The Physiology of Domestic Animals. 5th ed. Comstock Publishing Co., Ithaca, N. Y. 1942.

(5) Eveleth, D. F., Eveleth, M. W., and Walsh, F. E. Inorganic Phosphorus of the Serum of Dairy Cattle. North Amer. Vet., **18**: 18–22. 1937.

(6) Ferguson, L. C., Irwin, M. R., and Beach, B. A. On Variation in the Blood Cells of Healthy Cattle. Jour. Infect. Dis., **76**: 24–30. 1945.

(7) Fiske, C. H., and Subbarow, Y. The Colorimetric Determination of Phosphorus. Jour. Biol. Chem., **66**: 375–400. 1925.

(8) Gradwohl, R. B. H. Clinical Laboratory Methods and Diagnosis. 3rd ed. **1**: 416. The C. V. Mosby Co., St. Louis, Mo. 1943.

(9) Haag, J. R., and Jones, I. R. The Calcium and Inorganic Phosphorus Contents of the Blood Plasma of Normal Dairy Cattle. Jour. Biol. Chem., **110**: 439–441. 1935.

(10) Henderson, H. O., and Van Landingham, A. H. Method for Obtaining Representative Samples of Blood for Inorganic Phosphorus in Dairy Heifers. Jour. Dairy Sci., **15**: 313–319. 1932.

(11) Huffman, C. F., Duncan, C. W., Robinson, C. S., and Lamb, L. W. Phosphorus Requirements of Dairy Cattle when Alfalfa Furnishes the Principal Source of Protein. Mich. Agr. Expt. Sta. Bul. 134. 1933.

(12) Johnson, S. R. The Level of Inorganic Phosphorus in the Blood of Dairy Cattle. Jour. Nutr., **17**: 15–21. 1939.

(13) McCay, C. M. The Hemoglobin and Total Phosphorus in the Blood of Cows and Bulls. Jour. Dairy Sci., **14**: 373–378. 1931.

(14) Neal, W. M., and Becker, R. B. The Hemoglobin Content of the Blood of Healthy and Anemic "Salt Sick" Cattle. Jour. Agr. Res., **46**: 557–563. 1933.

(15) Palmer, L. S., Cunningham, W. S., and Eckles, C. H. Normal Variation in the Inorganic Phosphorus of the Blood of Dairy Cattle. Jour. Dairy Sci., **13**: 174–195. 1930.

(16) Palmer, L. S., and Eckles, C. H. Effect of Phosphorus Deficient Rations on Blood Composition in Cattle. Soc. Expt. Biol. and Med. Proc., **24**: 307–309. 1927.

(17) Palmer, L. S., and Eckles, C. H. Normal Variations in the Calcium Content of the Blood of Dairy Cattle. Jour. Dairy Sci., **13**: 351–359. 1930.

(18) Robinson, C. S., and Huffman, C. F. Studies on the Chemical Composition of Beef Blood. 1. The Concentration of Certain Constituents in Normal Plasma. Jour. Biol. Chem., **67**: 245–255. 1926.

(19) Scarborough, R. A. The Blood Picture of Normal Laboratory Animals. Yale Jour. Biol. and Med., **4**: 69–95. 1931–1932.

(20) Snedecor, C. W. Statistical Methods, 3rd ed. Iowa State College Press, Ames, Iowa. 1940.

(21) Sub-Committee on Nutrition of Dairy Cattle. Recommended Nutrient Allowances for Domestic Animals, No. 3. Recommended Nutrient Allowances for Dairy Cattle. National Research Council, Washington, D. C. 1945.

(22) VAN LANDINGHAM, A. H., HENDERSON, H. O., AND BOWLING, G. A. Studies on the Chemical Composition of the Blood of Dairy Cattle. I. The Effect of Age and Phosphorus Intake on the Calcium and Inorganic Phosphorus Content of Whole Blood of Dairy Heifers. JOUR. DAIRY SCI., **18**: 557–572. 1935.

(23) VAN LANDINGHAM, A. H., HENDERSON, H. O., AND BOWLING, G. A. II. The Effect of Phosphorus Intake on the Calcium and Inorganic Phosphorus Content of Whole Blood of Dairy Heifers During the Period of First Gestation and Lactation. JOUR. DAIRY SCI., **19**: 597–609. 1936.

(24) VAN LANDINGHAM, A. H., HENDERSON, H. O., AND BOWLING, G. A. III. The Normal Concentration of Inorganic Phosphorus in the Whole Blood of Dairy Cattle and Factors Affecting It. JOUR. DAIRY SCI., **25**: 537–548. 1942.

(25) WILSON, L. T., AND HART, E. B. The Chemistry of the Blood of Dairy Cows Before and After Parturition, and Its Relation to Milk Fever. JOUR. DAIRY SCI., **15**: 116–141. 1932.

# THE EFFECT OF COTTONSEED IN THE RATION ON PERCENTAGE OF FAT AND SERUM SOLIDS CONTENT OF MILK

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A number of studies have been made of the effect of different fats in the ration on the fat content of the milk (1, 2, 3, 4, 5, 8, 9, 10). Some of these were impractical because refined oil was used and in some instances fed in large amounts. Also, some experiments were not of sufficient duration to be conclusive.

Tests have been made with cottonseed meal and cottonseed oil but no reference is made to whole cottonseed. McCandlish (6) substituted cottonseed meal for both bran and linseed oil meal in rations of six cows—one Jersey, one Guernsey, and four Holsteins for 9 days of a 33-day period which alternated with 4 to 5 days in each of four check periods, 3 days in each of three experimental periods, and 2 to 3 days in the three transition periods, and noted very small changes in fat content and milk yield. This investigator also substituted cottonseed meal for the cracked corn in the ration with the result that a marked increase in the fat content occurred. Allen (1) supplemented rations with linseed oil, lard, corn oil, cottonseed oil, tallow, and butterfat in two 6-day periods using two Jersey, two Guernsey, and two Holstein cows, noted increases in butterfat production equivalent to 10 to 20 per cent of the additional fat fed. Allen and Fitch (2) noted marked increases when 1.5 pounds of butterfat, lard, or tallow were fed to two cows daily for 50 days. Cottonseed oil, linseed oil, cocoanut oil, or peanut oil produced small increases and soybean oil and corn oil produced decreased butterfat. Gibson and Huffman (3) do not concur with Allen's results when soybean oil was fed to two groups of four cows each in 24-day reversal periods. These investigators found that an increase in fat content of the milk was temporary, and the fat percentage returned to the normal level. Miller and Wise (7) found that at the end of a 4-month period, the milk produced by five to ten cows on a cottonseed meal ration had a lower fat content than the control. Woodward (10) conducted a series of 10-day tests and noted an increase in fat yield from 4.38 per cent during the control to 4.84 per cent when the four cows were fed cottonseed meal in amounts of 6.8 pounds to 11.2 pounds.

## EXPERIMENTAL

Twelve cows—two Guernseys, four Jerseys, and six Holsteins—were divided into two groups with consideration given to breed, age, weight, period of lactation, and yield. Each group contained one Guernsey, two Jerseys, and three Holsteins. The experiment was conducted for three

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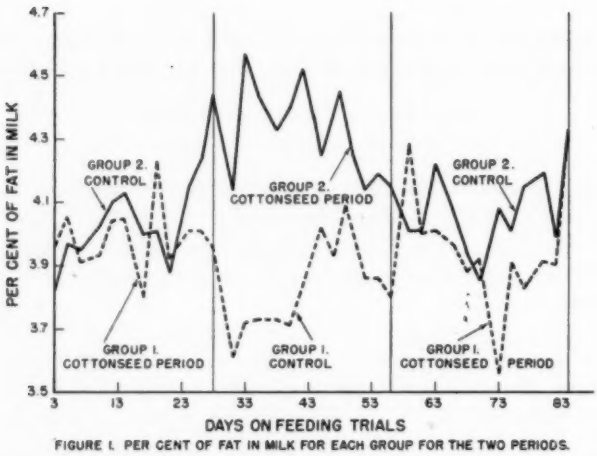


FIG. 1. Percentage of fat in milk for each group for the two periods.

reversal periods of 28 days each, during February, March, April, and May. Group I received cottonseed during the first and third periods and Group II during the second period. The cows were machine milked twice daily.

The cows received all the alfalfa hay which they would eat. The cows all had pasture a few hours daily when available. The pasture consisted of barley, oats, rye grass, and alfalfa. A concentrate mixture of 630 pounds of rolled barley, 600 pounds of wheat bran, and 150 pounds of cottonseed meal was used. This was fed to the Jerseys at the rate of 1 pound for each 3 pounds of milk produced, Guernseys, 1 for each 4 pounds, and Holsteins, 1 for each 5 pounds of milk produced. This mixture contained 13.6 per cent digestible protein, 5.6 per cent fat, and 73.7 per cent total digestible nutrients. The only difference in the ration of the two groups was the replace-

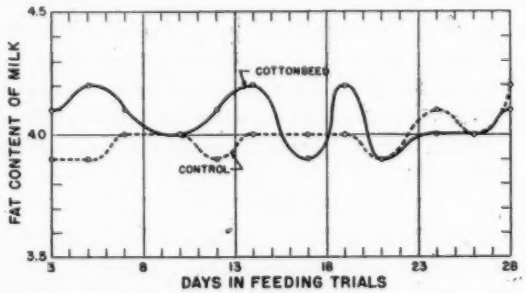


FIG. 2. Combined daily average fat percentage for the two groups for both the cottonseed and control periods.

ment of 2 pounds of the concentrate with 2 pounds of cottonseed. Cottonseed is reported, on 64 analyses (8), to contain 17.0 per cent digestible protein, 23.0 per cent fat, and 91.0 per cent total digestible nutrients.

When 2 pounds of the basal grain ration was replaced with a similar amount of cottonseed, the digestible protein of the mixture was increased 1.33 per cent and 0.91 per cent when fed in amounts from 5.2 to 12.2 pounds per cow, as shown in table 2. The fat content of the mixture containing cottonseed varied from 12.42 to 8.44 per cent in the above feedings. Total digestible nutrients were increased 6.78 and 2.83 per cent, respectively, by the replacement two of the 5.2 pounds of grain for Cow No. 141 and the 12.2 pounds for Cow No. 241.

Daily composite milk samples were taken Mondays, Wednesdays, and Fridays throughout the experiment and tested for fat—Babcock method, and total solids—Mojonnier method. The serum solids were determined by difference.

## DISCUSSION

The data show that the replacement of 2 pounds of the concentrates with 2 pounds of cottonseed in the ration resulted in a temporary increase of fat in the milk. The production of Guernsey cow No. 34 is not included in the data because this cow refused to eat the cottonseed during the latter part of the experiment.

Table 1 shows the milk produced during the 28-day periods for each cow for both the cottonseed and control periods and the average per cent of fat, total solids, and serum solids.

TABLE 1

*Milk produced and per cent fat, total solids and serum solids of the milk of each cow for the two periods*

| Cow No. | Cottonseed | | | | Control | | | |
|---|---|---|---|---|---|---|---|---|
| | Milk | Fat | T.S. | S.S. | Milk | Fat | T.S. | S.S. |
| **Group I** | | | | | | | | |
| | *lbs.* | % | % | % | *lbs.* | % | % | % |
| 122 | 765.3 | 5.16 | 14.09 | 8.93 | 778.0 | 4.78 | 13.82 | 9.04 |
| 141 | 429.4 | 5.70 | 14.86 | 9.16 | 439.2 | 5.70 | 14.86 | 9.16 |
| 219 | 1376.8 | 3.25 | 11.59 | 8.34 | 1469.8 | 3.12 | 11.54 | 8.42 |
| 225 | 1161.6 | 3.68 | 12.16 | 8.48 | 1202.4 | 3.63 | 12.13 | 8.50 |
| 237 | 1253.0 | 3.67 | 12.25 | 8.58 | 1267.7 | 3.61 | 12.15 | 8.54 |
| **Group II** | | | | | | | | |
| | *lbs.* | % | % | % | *lbs.* | % | % | % |
| 39 | 724.1 | 4.92 | 13.95 | 9.03 | 711.5 | 4.65 | 13.70 | 9.05 |
| 129 | 845.1 | 5.27 | 14.19 | 8.92 | 856.4 | 4.94 | 13.91 | 8.97 |
| 143 | 557.9 | 6.01 | 15.54 | 9.53 | 555.6 | 5.37 | 14.98 | 9.61 |
| 221 | 1079.3 | 3.81 | 12.23 | 8.42 | 1126.9 | 3.63 | 12.04 | 8.41 |
| 226 | 983.7 | 3.46 | 11.81 | 8.35 | 902.4 | 3.34 | 11.72 | 8.38 |
| 241 | 1363.5 | 3.59 | 12.12 | 8.53 | 1297.3 | 3.45 | 11.93 | 8.48 |

TABLE 2

*Showing average daily milk production, amount of grain fed, and analyses of modified grain mixture when two pounds of cottonseed were substituted*

| Cow No. | Breed | Cottonseed period | | | | | Control | |
|---|---|---|---|---|---|---|---|---|
| | | Average pounds milk per day | Pounds of modified grain ration | Per cent digestible protein | Per cent fat | Per cent T.D.N. | Average pounds milk per day | Pounds of basal grain ration |
| 122 | Jersey | 27.33 | 9.1 | 14.34 | 9.42 | 77.50 | 27.79 | 9.3 |
| 141 | Jersey | 15.34 | 5.1 | 14.93 | 12.42 | 80.48 | 15.69 | 5.2 |
| 219 | Holstein | 49.17 | 9.8 | 14.29 | 9.15 | 77.23 | 52.49 | 10.5 |
| 225 | Holstein | 41.49 | 8.3 | 14.41 | 9.79 | 77.86 | 42.94 | 8.6 |
| 237 | Holstein | 44.75 | 9.0 | 14.35 | 9.46 | 77.54 | 45.28 | 9.1 |
| 39 | Guernsey | 25.86 | 6.5 | 14.64 | 10.95 | 80.25 | 25.41 | 6.4 |
| 129 | Jersey | 30.18 | 10.0 | 14.28 | 9.08 | 77.16 | 30.59 | 10.2 |
| 143 | Jersey | 19.92 | 6.6 | 14.63 | 10.87 | 78.94 | 19.84 | 6.6 |
| 221 | Holstein | 38.55 | 7.7 | 14.48 | 10.12 | 78.17 | 32.23 | 6.4 |
| 226 | Holstein | 35.13 | 7.0 | 14.57 | 10.57 | 78.64 | 32.23 | 6.4 |
| 241 | Holstein | 48.70 | 12.2 | 14.16 | 8.44 | 76.53 | 46.33 | 11.6 |

Table 2 shows the average daily milk production and the amount and analyses of the concentrates which each cow received. The digestible protein content of the modified grain ration was increased from 13.6 per cent to 14.16 to 14.93 per cent, the fat content of 5.6 per cent increased to 8.44 to 12.44 per cent, and total digestible nutrients increased from 73.7 per cent in the basal ration to 76.53 to 80.48 per cent.

The average fat test was higher during the cottonseed period for every cow except one. Jersey cow No. 141 tested the same for both periods. Jersey cow No. 143 gave the largest increase, viz., 0.64 per cent. The average increase of Group I was 0.13 per cent and that of Group II was 0.24 per cent.

There was not any material difference in the milk yield for the two periods. The total solids was slightly higher for the cottonseed period. This was caused by the higher fat. It is interesting to note that the cotton-

TABLE 3

*Ratio of fat to serum solids*

| Group I | | | Group II | | |
|---|---|---|---|---|---|
| Cow No. | Ratio fat : S.S. | | Cow No. | Ratio fat : S.S. | |
| | Cottonseed 1 : | Control 1 : | | Cottonseed 1 : | Control 1 : |
| 122 | 1.731 | 1.891 | 39 | 1.835 | 1.946 |
| 141 | 1.607 | 1.666 | 129 | 1.692 | 1.815 |
| 219 | 2.566 | 2.698 | 143 | 1.585 | 1.789 |
| 225 | 2.304 | 2.341 | 221 | 2.209 | 2.317 |
| 237 | 2.337 | 2.365 | 226 | 2.410 | 2.509 |
| | | | 241 | 2.376 | 2.458 |

seed produced an increase in fat without a corresponding increase in serum solids. Table 3 gives the ratio of fat to serum solids for each cow for the two periods.

Table 4 gives the average daily milk production and average fat test for each cow for both periods. The fat tests for Group I averaged higher during the two cottonseed periods than the control period with variations during the 28-day periods of 3.80 to 4.23 per cent and 3.55 to 4.34 per cent as compared to 3.61 to 4.09 per cent during the control period. Group II likewise had a higher fat test during the cottonseed feeding period with tests of 4.14 to 4.57 per cent as compared to 3.83 to 4.44 per cent and 3.85 to 4.33 per cent in the two control periods.

TABLE 4

*Average daily milk production and average fat test for each cow*

Group I

| | Cow 122 | | Cow 141 | | Cow 219 | | Cow 225 | | Cow 237 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Milk | Fat | Milk | Fat | Milk | Fat | Milk | Fat | Milk | Fat |
| | *lbs.* | % | *lbs.* | % | *lbs.* | % | *lbs.* | % | *lbs.* | % |
| Cottonseed | 27.33 | 5.16 | 15.34 | 5.70 | 49.17 | 3.25 | 41.49 | 3.68 | 44.75 | 3.67 |
| Control | 27.79 | 4.78 | 15.69 | 5.70 | 52.49 | 3.12 | 42.94 | 3.63 | 45.28 | 3.61 |
| | −0.46 | +0.38 | −0.35 | 0.0 | −3.32 | +0.13 | −1.45 | +0.05 | +0.53 | +0.06 |

Group II

| | Cow 39 | | Cow 129 | | Cow 143 | | Cow 221 | | Cow 226 | | Cow 241 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Milk | Fat | Milk | Fat | Milk | Fat | Milk | Fat | Milk | Fat | Milk | Fat |
| | *lbs.* | % | *lbs.* | % | *lbs.* | % | *lbs.* | % | *lbs.* | % | *lbs.* | % |
| Cottonseed | 25.86 | 4.92 | 30.18 | 5.27 | 19.92 | 6.01 | 38.55 | 3.81 | 35.13 | 3.46 | 48.70 | 3.59 |
| Control | 25.41 | 4.65 | 30.59 | 4.94 | 19.84 | 5.37 | 40.25 | 3.63 | 32.23 | 3.34 | 46.33 | 3.45 |
| | +0.45 | +0.27 | −0.41 | +0.33 | +0.08 | +0.64 | −1.70 | +0.18 | +2.90 | +0.12 | +2.37 | +0.14 |

There was a great fluctuation in fat tests during the cottonseed period. The test for this period was the same as that of the control on the tenth day, lower on the seventeenth day, and the same again on the twentieth. The test for the cottonseed period averaged slightly less than that of the control during the last 8 days of the experiment. The highest combined test for the cottonseed period was on the nineteenth day.

The results of this study are similar to those obtained by McCandlish (6) in which cottonseed meal increased the fat content of the milk for short periods. These findings are not in accord with those of Allen (1) who found no indication of a return to the normal level after six weeks of a high fat intake.

## SUMMARY AND CONCLUSIONS

An experiment to study the effect of feeding cottonseed on the fat and serum solids content of the milk was conducted using twelve cows for three 28-day reversal periods.

1. The replacement of 2 pounds of the concentrates in the ration with 2 pounds of cottonseed produced an increase in the fat content for the first 20 days.

2. The fat test for the last 8 days of the experiment was slightly lower than that of the control. The fat test of the cottonseed feeding periods were higher, with a combined range of 3.55 to 4.57 per cent as compared to 3.61 to 4.44 per cent for the combined control periods.

3. There was no significant difference in the milk production for the two periods.

4. The cottonseed did not produce a corresponding increase in serum solids. In fact, the serum solids content was slightly reduced.

5. Palatability of cottonseed is a limiting factor in its use when mixed with rolled barley, wheat bran, and cottonseed meal.

## REFERENCES

(1) ALLEN, N. N. The Fat Percentage of Milk as Affected by Feeding Fat to Dairy Cows. JOUR. DAIRY SCI., **17**: 379–395. 1934.

(2) ALLEN, N. N., AND FITCH, J. B. Influence of Sustained High Fat Intake Upon Milk Fat Production. (Abstract) JOUR. DAIRY SCI., **24**: 517–518. 1941.

(3) GIBSON, G., AND HUFFMAN, C. F. The Influence of Different Levels of Fat in the Ration Upon Milk and Fat Secretion. Mich. Agr. Expt. Sta. Quarterly Bul., **21**, 4: 258–264. May, 1939.

(4) HALVERSON, J. O., AND SHERWOOD, F. W. Investigations in the Feeding of Cottonseed Meal to Dairy Cattle. North Carolina Agr. Expt. Sta. Technical Bul. 39. 1930.

(5) HUFFMAN, C. F., AND MOORE, L. A. Cottonseed Meal Studies. III. Heavy Feeding of Cottonseed Meal to Dairy Cattle During Reproduction and Lactation. JOUR. DAIRY SCI., **13**: 478–493. 1929.

(6) MCCANDLISH, A. C. The Use of Cottonseed Meal to Increase Fat Percentage in Milk. JOUR. DAIRY SCI., **4**: 310–333. 1921.

(7) MILLER, P. G., AND WISE, G. H. The Effect of Feeding Cottonseed Meal. JOUR. DAIRY SCI., **27**: 275–296. 1944.

(8) MORRISON, F. B. Feeds and Feeding. Table I, 976–991. 20th edition. 1945.

(9) NEVENS, W. B., ALLEMAN, M. B., AND PECK, L. T. The Effect of Fat in the Ration Upon Percentage of Fat Content of the Milk. JOUR. DAIRY SCI., **9**: 307–337. 1925.

(10) WILLIAMS, N. K., CANNON, C. Y., AND ESPE, D. L. A Soybean and Silage Ration for Dairy Cows. JOUR. DAIRY SCI., **26**: 241–249. 1943.

(11) WOODWARD, T. E. Factors Influencing Percentage of Fat in Milk. JOUR. DAIRY SCI., **6**: 466–478. 1923.

# BABCOCK VS. MOJONNIER TEST FOR HOMOGENIZED AND UNHOMOGENIZED MILK

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The homogenization of a considerable portion of the market milk supply has become part of the processing procedure in many milk plants throughout the country. The value of homogenization has been given considerable attention in the literature. According to Hollingsworth (1), dairymen soon found that the Babcock test of pasteurized milk showed discrepancies with fat tests of the same milk after homogenization. The reason given for this difference was due to the decreased size of the fat globules in the homogenized milk. The minute globules could not be completely raised into the fat column by the action of sulfuric acid and centrifugal force in the Babcock test.

## REVIEW OF LITERATURE

Trout (5) reported on 12 groups of Babcock tests on milk homogenized at 500, 1500, and 2500 pounds pressure at 90° and 145° F. The results show no practical or significant difference from unhomogenized milk. The milk homogenized at 2500 pounds resulted in fat tests 0.034 and 0.021 of a per cent lower for the respective homogenization temperatures. Hood and White (2) reported a variation of 0.08 of a per cent lower when the milk was homogenized at 3500 pounds pressure. Lower pressures gave less variation. Comparisons were made on 50 tests by Phillips (4) who reported that on unhomogenized milk, the Babcock test averaged 0.0588 of a per cent higher than the Mojonnier. No reference was made in the literature to comparisons of the Babcock and Mojonnier methods of determining butterfat content of homogenized milk.

## EXPERIMENTAL PROCEDURE

Fat tests were conducted on unhomogenized milk and milk homogenized at 150° F. at 1500, 2000, 2500, 3000, and 4000 pounds pressure.. The fat content of the milk varied from 3.2 to 4.4 per cent. The milk sample tested in duplicate by the Babcock method was pipetted directly into the milk test bottle. Sulfuric acid (sp. gr. 1.82) was added in three portions and shook twenty seconds after each addition of acid. The mixture was also shaken after the first addition of hot water when centrifuging. No unsatisfactory tests resulted. The samples were tempered at 135° to 140° F. for five minutes before reading.

The Mojonnier tests were conducted in accordance with instructions

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TABLE 1

*Showing comparative fat tests and the range of variations of unhomogenized and homogenized milk by the Babcock and Mojonnier methods*

| Pressure | Number of tests | Babcock | | | | Mojonnier | | | | Average difference between Babcock & Mojonnier | Extreme variations of the two methods |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Range of fat tests | | | | Range of fat tests | | | | | |
| | | High | Low | Average | Variation | High | Low | Average | Variation | | |
| | | | | | | | | | | % | |
| 0 | 27 | 3.937 | 3.906 | 3.921 | 0.031 | 3.980 | 3.967 | 3.975 | 0.013 | +0.054 | 3.906–3.980 |
| 1500 | 8 | 3.913 | 3.869 | 3.891 | 0.044 | 3.979 | 3.968 | 3.973 | 0.011 | +0.082 | 3.869–3.979 |
| 2000 | 24 | 3.856 | 3.833 | 3.843 | 0.023 | 3.957 | 3.940 | 3.948 | 0.017 | +0.105 | 3.833–3.957 |
| 2500 | 23 | 3.854 | 3.830 | 3.842 | 0.024 | 3.946 | 3.932 | 3.939 | 0.014 | +0.097 | 3.830–3.946 |
| 3000 | 24 | 3.860 | 3.813 | 3.837 | 0.037 | 3.945 | 3.935 | 3.940 | 0.010 | +0.103 | 3.813–3.945 |
| 4000 | 5 | 4.051 | 4.020 | 4.036 | 0.030 | 4.163 | 4.147 | 4.155 | 0.016 | +0.119 | 4.020–4.163 |
| Homogenized milk | 84 | 3.873 | 3.841 | 3.857 | 0.032 | 3.966 | 3.952 | 3.959 | 0.014 | +0.102 | 3.830–4.163 |

outlined by the manufacturer (3). The samples were pipetted into the extraction flasks.

## RESULTS

Table 1 shows the results of the fat tests of unhomogenized milk and milk homogenized at the various pressures. The range of fat tests shows the variations between duplicate tests. The average of the high or original tests by the Babcock method for unhomogenized milk was 3.937 per cent as compared to the low or duplicate tests which averaged 3.906 per cent. The variation of the 27 pairs of samples was 0.031 per cent as compared to 0.032 per cent for 84 samples of homogenized milk tested in duplicate. The corresponding variations among unhomogenized and homogenized samples of milk by the Mojonnier method were 0.013 and 0.014 per cent, respectively.

The above-mentioned table also shows the difference in tests of unhomogenized and homogenized milks by the Babcock and Mojonnier methods.

## DISCUSSION

The average test of 27 samples of unhomogenized milk was 3.921 per cent by the Babcock method as compared to 3.975 per cent by the Mojonnier method. This difference, in which the unhomogenized milk tested 0.054 of a per cent lower by the Babcock, is not in agreement with work of Phillips (4). This investigator reported the Babcock test of unhomogenized milk averaged 0.0588 of a per cent higher than the Mojonnier comparisons. The difference in fat tests between the Babcock and Mojonnier methods of milk homogenized at 1500, 2000, 2500, 3000, and 4000 pounds pressure were 0.082, 0.105, 0.097, 0.103, and 0.119 of a per cent, respectively. The difference between tests by the Babcock method of unhomogenized and homogenized milk is in agreement with results of Hood and White (2) who report that, at 3500 pounds pressure, the homogenized milk tested 0.08 of a per cent lower than the unhomogenized milk. Lower pressures resulted in correspondingly lower variations.

The variations between samples of milk tested by the Babcock method were essentially the same for both the unhomogenized and homogenized samples, the difference being 0.031 and 0.032 of a per cent, respectively. Table 1 also shows that the Babcock test gave lower results on homogenized milk. The milk homogenized at 1500 pounds pressure tested 0.030 of a per cent lower than the unhomogenized milk. Pressures of 2000, 2500, and 3000 pounds resulted in decreases of 0.078, 0.079, and 0.084 of a per cent for the respective pressures than unhomogenized milk.

Less discrepancies were noted in the range of fat tests by the Mojonnier method which show variations of 0.013 and 0.014 of a per cent for unhomogenized and homogenized milk, respectively. The homogenized milk also had fat tests with less deviation from the unhomogenized samples than the Babcock method.

SUMMARY

The results of 8, 24, 23, 24, and 5 samples of milk homogenized at 1500, 2500, 3000, and 4000 pounds pressure, respectively, were averaged. The extreme variation in fat tests by the two methods was noted in the samples homogenized at 4000 pounds, in which the Mojonnier results were 0.119 of a per cent higher than the Babcock. Samples homogenized at 1500, 2000, 2500, and 3000 pounds pressure had variations of 0.082, 0.105, 0.097 and 0.103 of a per cent, respectively. The average discrepancy between the two tests of the 84 samples of homogenized milk was 0.102 of a per cent. The Mojonnier method was higher in 80 of 84 samples of homogenized milk tested. The Babcock test was only slightly higher on four samples with average differences of 0.001, 0.005, 0.009, and 0.050 of a per cent.

The 27 samples of unhomogenized milk tested show that the Mojonnier method was 0.054 of a per cent higher than the Babcock. In 22 of the 27 samples, the Mojonnier tests averaged 0.058 of a per cent higher, and in the 5 remaining tests the Babcock exceeded by 0.038 of a per cent.

The Babcock test of the milk used in this study was 3.2 per cent to 4.4 per cent fat. No significant difference was noted in variations between these two methods of the 3.2 and 4.4 per cent milks.

REFERENCES

(1) HOLLINGSWORTH, J. B. Homogenized Market Milk—How It Is Increasing Consumption in Canada. Milk Dealer, 20(9): 63. 1931.

(2) HOOD, E. G., AND WHITE, A. H. Homogenization of Market Milk—as reported by R. J. Quirie in Proceedings of International Assoc. of Milk Dealers. 28th Annual Conv. Plant Section, 67–91. 1935.

(3) Mojonnier Bros. Co. Instruction Manual Bul. 101, 1925.

(4) PHILLIPS, C. A. A Comparison of the Babcock and the Reese Gottlieb (Mojonnier) Methods of Determining Fat in Milk. JOUR. DAIRY SCI., 6: 549–555. 1923.

(5) TROUT, G. M., HALLORAN, C. P., AND GOULD, I. The Effect of Some of the Chemical and Physical Properties of Milk. Mich. Agr. Expt. Sta. Tech. Bul. 145: 18–19. 1935.

# STORAGE AND TREATMENT OF MILKING MACHINE INFLATIONS*

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The storage and treatment of milking machine inflations has been given considerable attention and yet no single procedure for caring for them has been generally adopted. Chlorine and lye solutions have undoubtedly been most prevalently used where solution racks are employed, while dry storage following washing has been used by many producers.

Early investigation on the handling of inflations and rubber parts include treatment with steam and hot water and storage in solutions of vinegar, acetic acid, potassium permanganate, hydrogen peroxide, alcohol, "Gold Dust," formalin, salt, lime, borax, and chloride of lime. An excellent review of treatment as applied to rubber up until the year 1920 has been presented by Hart and Stabler (2). Of these early used sanitizing agents hot water and chlorine solutions have survived, while salt has also been used in a limited degree as an aid to prevent freezing when blended with chlorine or lye solutions. Steam, although effective as a germicide, was found by Stocking and Mason (7) to seriously injure rubber.

Deteriorating action by chlorine on rubber was noted by Hart and Stabler (2), who also showed that both milk and rubber reduced the chlorine content of solutions containing it. These workers advocated the use of hot water at 180° F. for 15 minutes as the most practical means of sterilizing under ordinary ranch conditions. Henderson, Roadhouse, and Folger (3) reported that heating rubber parts in hot water at 185° F. for 20 minutes was much more effective as a sterilizer than at 170° F. for the same period, and did not appreciably shorten the life of the rubber; though both heat treatments reduced the life of rubber about one-third when compared with chlorine. These workers failed to report deteriorating action on rubber from the use of chlorine although a solution strength of 200 p.p.m. of chlorine was used.

Lye at 0.3 to 0.5 per cent concentration was found by Parfitt (6) and Johns (4) effective in reducing bacteria counts on milk when used for storage solutions. More recent development in treatment of rubber inflations has included boiling them in lye solutions periodically, using four heaping teaspoonfuls of household lye for each quart of water. This procedure as developed by Moir (5) saponifies the rubber-entrained fat, thus restoring elasticity to the rubber.

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Observation made of rubber deterioration on milking machines on which data on washing procedure and results were being gathered suggested that further study of the various storage procedure should be made for the purpose of determining, (a) the effect of various chlorine and other storage solutions on synthetic rubber, (b) the fat absorption qualities of inflations and (c), other evidence calling attention to better care of milker inflations and rubber parts.

## EXPERIMENTAL

*Effect of sanitizing solutions on synthetic inflations.* To determine the effect of sanitizing solutions frequently recommended for rubber inflation storage on synthetic rubber deterioration, twenty new inflations were branded with a number for identification; following which they were washed, dried for a period of 4 hours at room temperature and were then weighed. Sanitizing solutions were prepared and adjusted to correct concentration of parts per million in all the chlorine solutions used, as well as "Roccal" solution. The acid and alkaline solutions were prepared by weighing the amount required to produce a 0.5 per cent concentration. All solutions were prepared fresh. Once each week day one designated inflation from each jar was removed and worked by repeated stretching in fresh whole milk. This working of inflations in milk was regulated to one minute duration, following which they were thoroughly rinsed with clear tap water. At the close of each week all the inflations were removed, rinsed in clear water and again dried for a 4-hour period at room temperature, after which all inflations were weighed. Similar treatment was continued for thirteen weeks for all but two solutions, "Calgonite" and "Perfection," which were stored 65 and 42 days respectively.

The results are shown in table 1. Appreciable gain in weight occurred with storage in all solutions except lye. Greatest gain, however, occurred with the more highly active chlorine solutions, particularly "Lobax," "B K" and "H.T.H. 15." The "Nu Kleen" acid solution also resulted in gains practically as high as obtained with the more highly active chlorine solutions. Very slight gain in weight occurred in the lye solution. The significance of gain in weight was not ascertained. However, it is likely that excessive weight gains are associated with reduction in strength of rubber, for in extreme cases of swelling, such as was observed in connection with organic solvents, later reported in this study, the rubber was swollen and softened to the extent that it would tear with very little effort.

Significantly higher increases in gains of weight occurred in the milk-treated inflations than in those only treated in solutions. Also, deterioration as marked by softening and peeling of rubber occurred on milk-treated rubber when stored in "B K," "Lobax" and "H.T.H." solutions. Roughening of the rubber inflations as determined by scraping the inner surfaces with a metal-bladed spatula resulted with all chlorine storage when the milk treat-

TABLE 1

*Showing effect of storing rubber inflations in different solutions on weight increase and rubber deterioration*

| Product | Solution strength | Number days held | Per cent wt. increase | | Rubber appearance | | |
|---|---|---|---|---|---|---|---|
| | | | Milk treated | Not milk treated | Color | Texture | Deterioration |
| I Sterichlor | 200 p.p.m. | 91 | ..... | 3.00 | Shiny black | Smooth | ..... |
| | 200 p.p.m. | 91 | 3.00 | ..... | Shiny black | Sl. rough | ..... |
| III B.K. | 200 p.p.m. | 91 | ..... | 2.59 | Brown | Sl. rough | + |
| | 200 p.p.m. | 91 | 5.19 | ..... | Brown | Rough | ++ |
| V L.Bax | 200 p.p.m. | 91 | ..... | 3.90 | Brown | Sl. rough | ..... |
| | 200 p.p.m. | 91 | 8.00 | ..... | Brown | Rough | ++ |
| VII Diversol | 200 p.p.m. | 91 | ..... | 2.63 | Black | Smooth | ..... |
| | 200 p.p.m. | 91 | 4.40 | ..... | Black | Sl. rough | ..... |
| XIII H.T.H. 15 | 200 p.p.m. | 91 | ..... | 2.77 | Dull black | Smooth | ..... |
| | 200 p.p.m. | 91 | 5.44 | ..... | Dull black | Sl. rough | + |
| XI Nu Kleen acid | 200 p.p.m. | 91 | ..... | 3.98 | Shiny black | Smooth | ..... |
| | 200 p.p.m. | 91 | 5.02 | ..... | Shiny black | Sl. tacky | ..... |
| IX Roccal | 200 p.p.m. | 91 | ..... | 2.90 | Shiny black | Sl. tacky | ..... |
| | 200 p.p.m. | 91 | 3.15 | ..... | Shiny black | Sl. tacky | ..... |
| XV Lye | 0.5% | 91 | ..... | 0.29 | Shiny black | Smooth | ..... |
| | 0.5% | 91 | 0.55 | ..... | Shiny black | Smooth | ..... |
| XVII Calgonite | 0.5% | 65 | ..... | 2.53 | Shiny black | Smooth | ..... |
| | 0.5% | 65 | 2.17 | ..... | Shiny black | Smooth | ..... |
| XIX Perfection | 0.5% | 42 | ..... | 1.84 | Shiny black | Smooth | ..... |
| | 0.5% | 42 | 2.23 | ..... | Shiny black | Smooth | ..... |

ment was applied. The "Nu Kleen" acid and "Roccal" solutions produced a tacky feel that was most noticeable when pressing the inner liners together and suddenly releasing the pressure. Color changes were noted. The color changed from an original shiny black to a brownish color as a result of the use of "B K" and "Lobax," while a dull black resulted from "H.T.H. 15." No apparent color changes occurred from the other solutions used. The slower chlorine-releasing products such as "Sterichlor" and "Diversol," would appear to be better suited for rubber storage than those of more active nature. The release of chlorine in an overly active solution can be materially inhibited by addition of tri-sodium phosphate as shown by Fay (1), who recommends that 100 grams trisodium phosphate be added to 1 gallon filtered calcium hypochlorite prepared from one 12-ounce can of chloride of lime.

*Fat extraction from rubber inflations.* The presence of fat in inflations has been previously shown by Moir (5), who demonstrated that inflations could be renovated by boiling in a strong lye solution.

The grayish appearance of the top half, or mouth end, of used milker inflations when stored for a period after discarding for reasons of breakage gave rise to the suspicion that fat absorption was greatest in that portion of the inflation that grips the teat. This, if so, would coincide with Moir's (5) reasoning that during the milking process a film of milk gathers between the teats and rubber, and some of the fat from the milk is gradually worked into the rubber.

As a means of determining the amount of fat that was worked into rubber, boiling with lye solution was tried, but no consistent results were secured when measured on a weight basis. This method was, therefore, discarded and organic fat solvents were decided upon. The solvents thought usable were ethyl ether, petroleum ether and Skelly Solve "A."

Extraction determinations were made on new synthetic rubber and latex rubber inflations to determine the amount of rubber that normally would be dissolved by the solvents during various time periods. These periods were selected as 2, 5, and 10 minutes when 100 ml. of each solvent was shaken with 10 grams of finely diced rubber particles. Another time trial was made for each kind of rubber using two 2-minute shaking periods, each with a 50-ml. portion of solvent. Following extraction, the extracts were poured into tared Mojonnier dishes and the solvents were evaporated in a Mojonnier vacuum oven. The weights of residue are shown in table 2.

From the results obtained it was apparent that synthetic rubber was more readily soluble than latex rubber in organic solvents. Also, it was seen that the amount dissolved was directly related to the time of exposure of rubber to solvent.

Of the solvents used petroleum ether was slightly lower in rubber dissolving action than Skelly Solve "A" and considerably lower in this respect

TABLE 2

*Showing grams of rubber dissolved from 10 grams of new milker inflation rubber when treated with various fat solvents**

| Minutes shaken | Solvents | | | | | |
|---|---|---|---|---|---|---|
| | Ethyl ether | | Petroleum ether | | Skelly Solve "F" | |
| | Synthetic | Latex | Synthetic | Latex | Synthetic | Latex |
| 2 | 0.2011 | 0.0718 | 0.1290 | 0.0577 | 0.1483 | 0.0485 |
| 5 | 0.2944 | 0.0967 | 0.1886 | 0.0748 | 0.2047 | 0.0729 |
| 10 | 0.4060 | 0.1603 | 0.2639 | 0.0938 | 0.2892 | 0.0941 |
| 2+2 | 0.2869 | 0.1037 | 0.1816 | 0.0657 | 0.1888 | 0.0682 |

* Results are average obtained on two series of trials.

than ethyl ether. Petroleum ether was, therefore, selected as the solvent to be used for making fat extraction determinations. Also, a period of five minutes was arbitrarily selected, as there was little difference in the duplicate determinations for any of the time periods used.

*Fat extraction from used synthetic rubber inflation.* To determine the amount of fat that could be extracted from used synthetic inflations the inflations were sectioned in such a manner as largely to remove the swollen and grayish black portions that showed signs of fat absorption. These were finely diced with razor blades and ten-gram portions were weighed and extractions made therefrom. The lower ends of the inflations were likewise diced and tested. Similarly inflations were tested that had been boiled in lye solution for 15- and 90-minute periods. This was done to determine the extent of fat removal by means of the lye treatment. The solution was made by adding 2 ounces of lye per gallon of water.

As a means of determining the amount of fat removed in these extractions the tare value of 0.1886 was applied to each. This being the amount dissolved on inflation rubber that had never been used. The results of these extractions are presented in table 3.

TABLE 3

*Showing per cent of net fat extracted from upper and lower portions of used milker inflations*

| Inflation number* | Minutes boiled in lye sol. | Net percentage fat extracted from 10 grams of synthetic rubber milker inflations | |
|---|---|---|---|
| | | Upper or mouth half | Lower half |
| | | *per cent* | *per cent* |
| 1 | 0 | 1.38 | 0.22 |
| 2 | 0 | 1.63 | 0.27 |
| 3 | 15 | 0.99 | 0.20 |
| 4 | 90 | 0.82 | 0.00 |

* Two determinations were made from each inflation section and the figures shown are their average.

Results from table 3 show that the upper portion of the inflation definitely absorbs fat to a greater extent than does the lower portion, although this lower portion is generally presumed to be more in contact with milk as it passes from the teat to the milker pail. Obviously the flexing of the rubber and the condition described by Moir (5), wherein a film of milk gathers between the teats and rubber, exists; thus resulting in milk fat being worked into the rubber.

Although no attempt was made in this trial to make tests for fat extraction of lye-boiled and nonboiled rubber from the same inflation, it was apparent that lye-boiling for 15 and 90 minutes reduced the fat content materially. However, despite boiling for a period of ninety minutes, the apparent amount remaining in the upper portion of the rubber was 0.82 per cent.

*Fat extraction made from used latex rubber inflations.* Extractions were made from sectioned latex rubber inflations similarly to synthetic inflations except that in order to make better determination of the influence of lye boiling, the inflations were divided longitudinally. Each half of these inflation parts was boiled in lye solution at 15; 30; and 90-minute intervals while the other halves were left unboiled. All halves were then transversely sectioned so that the distended portions indicating wear and fat absorption were separated from that of normal appearance. The line of demarkation generally appeared at approximately the midway portion of each inflation. To obtain the net fat extraction the tare figure of 0.0748 was deducted from all extraction weights. This being the amount of latex rubber extracted with petroleum ether in a 5-minute extraction period. Results are shown in table 4.

The results as presented in table 4 again show a decrease in fat as a result of boiling in lye solution and a greater fat reduction as the boiling treatment was increased. When boiling was applied for a period of 15 minutes 26.3 per cent of the total fat was saponified, with 30 minutes 40.7

TABLE 4

*Showing per cent of net fat extracted from upper and lower portions of sectioned used latex rubber milker inflations when boiled and not boiled in lye solutions*

| Inflation number | Minutes boiled in lye sol. | Net percentage fat extracted from 10 grams of latex rubber milker inflations | |
|---|---|---|---|
| | | Upper or mouth half | Lower half |
| | | *per cent* | *per cent* |
| 1 | 0 | 3.91 | 0.62 |
| | 15 | 2.88 | 0.31 |
| 2 | 0 | 5.79 | 0.72 |
| | 30 | 3.43 | 0.64 |
| 3 | 0 | 2.78 | 0.93 |
| | 90 | 1.11 | 0.37 |

per cent and with 90 minutes 60.1 per cent as determined from the losses of fat from the upper portions of rubber.

The total fat absorption was considerably higher in used latex rubber than in used synthetic. However, this may have been the result of longer period of usage in favor of the latex inflations. No record was obtained of the period of use of any of the rubber. Consequently, it could not be assumed that latex rubber was more fat absorbing than synthetic rubber.

*Lye-boiling effect on heat-resisting bacteria.* Since it was demonstrated that fat in substantial percentage was absorbed in inflations, it could be assumed that bacteria likewise could be absorbed with the fat and thus would impregnate the rubber in a manner that no amount of washing or surface treatment by chemical agents would be sufficient for adequate sanitization.

In substantiation of such a conjecture an actual instance is presented in which a short-tube-type milking machine was used. This milker was generally washed with only medium warm water and a high quality washing powder followed by rinsing with warm water to which a quarternary ammonia sanitizing agent was usually, but not always, added. On physical examination the milker pails and inflations appeared clean and entirely free of milkstone. Bacterial counts made bi-monthly for a period of several winter months on both raw and pasteurized samples of milk from this producer resulted in counts ranging from 127 thousand to 620 thousand in the raw samples and 85 thousand to 191 thousand in these samples after being laboratory pasteurized.

In order to determine the source of the bacteria that were not destroyed by pasteurization, arrangement was made with the owner to visit the farm during milking so that rinse counts could be made of the milking machine inflations before milking was begun and samples of milk taken for bacteria counts from each individual cow directly from the milker pails.

On the day of the tests the milking machines were washed in the house, whereas generally the washing was done in the milk house. The pail and the inflations had the appearance of thorough cleanliness.

The rinse samples were taken by removing the inflations from the milker pail head and pinching each inflation tubing to hold it shut so sterile rinse water could be held in the inflation until filled. The water was then allowed to run back into the jar. A 500-ml. portion of rinsing water was similarly applied to all milker inflations of a unit.

Despite the appearance of cleanliness noted in the milking machines the bacteria count of one set of inflations was over 10 million, while the laboratory pasteurized water sample had a count of over 7 million, both calculated as total count. In the second unit these counts were 4.5 million and 3.9 million, respectively. Also, all milk samples were high in both raw and pasteurized counts, with practically as high bacteria count in the milk from the last cows milked as in the milk from those milked first.

A week later a second series of tests were made. To assure having absolutely clean milking machines they were brought to the laboratory for cleaning. The milker pails were washed and rinsed with moderately hot water from a hose after which they were drained to dry. The rubber inflations were placed in a boiling lye solution, containing two ounces of lye per gallon of water, for a period of 30 minutes.

As a precaution udder samples were taken from the fore milk. These samples were taken aseptically by washing teats and udders with clean cloths dampened with chlorine solution. After discarding the first few streams of milk from each teat, milk was drawn directly into sterile test tubes. The samples were properly refrigerated and were plated within two hours. The results of bacteria counts made on the milker inflations and the milk from each cow as obtained before and after the lye boiling treatment are shown in tables 5 and 6.

TABLE 5

*Bacteria counts secured per 500 ml. of rinsing water applied to four inflations of each milker unit*

| Inflations | Unit #1 | | Unit #2 | |
|---|---|---|---|---|
| | Total | Thermodurie | Total | Thermodurie |
| Before boiling | 10,500,000 | 7,500,000 | 4,500,000 | 3,900,000 |
| After boiling | 1,000 | 500 | 1,000 | 500 |
| After rinsing following milking | 60,000 | 1,000 | 25,000 | 500 |

Results in table 5 show the bactericidal effect on total and heat resisting bacteria when highly contaminated milker inflations were boiled in lye solution. The resulting bacteria counts of 1000 total and 500 thermodurie were considered excellent. While the bacteria counts were greatly improved the rubber also showed improvement in freshness and in general texture.

Rinse counts made after milking was completed and after the milking machines were washed with only moderately warm water containing a wetting agent washing powder are also shown in table 5. An increase in count over that secured with lye boiling showed such washing to be inadequate for satisfactory germ destruction. Sanitizing following washing with hot water at 180 to 185° F. or with satisfactory chemical solutions was unquestionably required.

Table 6 shows the beneficial effect obtained from boiling milker inflations in lye solution in reducing both raw milk and pasteurized milk bacteria counts. Further, these results established fairly definitely that the high thermodurie counts difficulty from this milking machine came from the inflations rather than other suspected sources, as the milker pails were in apparent excellent state of cleanliness when the first check-up was made and were not washed in the laboratory with more than normal care.

A direct effect of utensil contamination on bacteria count is shown by the

TABLE 6

*Bacteria counts in milk from individual cows in the herd, showing counts secured before and after boiling apparently clean used inflations in a strong lye solution*

| Sample number | Bacteria count of milk | | | | | |
|---|---|---|---|---|---|---|
| | Before lye-boiling | | After lye-boiling | | Hand-milked fore milk | |
| | Raw | Pasteurized | Raw | Pasteurized | Raw | Pasteurized |
| 1 | 300,000 | 440,000 | 1,100 | 200 | 4,000 | 100 |
| 2 | 620,000 | 510,000 | 5,100 | 300 | 6,500 | 200 |
| 3 | 240,000 | 130,000 | 1,100 | 100 | 100 | 100 |
| 4 | 490,000 | 460,000 | 2,000 | 100 | 600 | 100 |
| 5 | 47,000 | 15,000 | 7,200 | 2,000 | 24,000 | 200 |
| 6 | 240,000 | 180,000 | 1,400 | 200 | 1,400 | 100 |
| 7 | 230,000 | 150,000 | 1,200 | 200 | 600 | 100 |
| 8 | 300,000 | 250,000 | 3,300 | 100 | 4,200 | 100 |
| 9 | 250,000 | 180,000 | 1,500 | 200 | 800 | 200 |
| 10 | 140,000 | 120,000 | 1,500 | 100 | 6,800 | 200 |
| 11 | 150,000 | 140,000 | 1,800 | 500 | 800 | 100 |
| 12 | 100,000 | 90,000 | 900 | 500 | 300 | 100 |
| 13 | 330,000 | 140,000 | 1,500 | 100 | 1,100 | 200 |
| 14 | 310,000 | 170,000 | 3,400 | 500 | 700 | 300 |

high counts in inflations and in milk in the first week's trials, while low bacteria counts in inflations and milk were obtained after the inflations had been boiled.

Contamination lodged in the inner pores of the rubber inflations would seem to be evident because bacteria counts were practically as high at the end of milking as at the beginning. Surface contamination only should result in a washing action with reduced counts as milking progresses.

TABLE 7

*Bacteria counts secured from inflation rinses and subsequent milk supply*

| Date | Bacteria count of | | | |
|---|---|---|---|---|
| | Rinse water | | Milk obtained on following day | |
| | Total | Thermoduric | Total | Thermoduric |
| 1–29 | 3,600,000 | 15,000 | 160,000 | 97,000 |
| 2– 4 | 5,400,000 | 1,500 | 180,000 | 130,000 |
| 2–18 | 15,000,000 | 170,000 | 180,000 | 180,000 |
| 3–.5 | 1,000 | 500 | 180,000 | 180,000 |
| 3–19 | 3,000 | 1,000 | 270,000 | 200,000 |
| 3–26 | 30,000,000 | 10,000 | 130,000 | 100,000 |
| 4– 2 | 9,000,000 | 550,000 | 43,000 | 42,000 |
| 4– 4* | 1,000 | 500 | ..... | ..... |
| 4– 9 | 73,000 | 1,500 | 40,000 | 10,000 |
| 4–15 | 3,000 | 1,500 | 40,000 | 1,500 |
| 4–23 | 3,000 | 500 | 120,000 | 7,000 |
| 4–30 | 2,000 | 500 | 15,000 | 5,500 |
| 5– 7 | 1,500 | 500 | 18,000 | 3,100 |
| 5–13 | 500 | 500 | 18,000 | 2,100 |
| 5–21 | 500 | 1,000 | 26,000 | 8,300 |

* Lye-boiled.

Following this washing experience the bacteria counts obtained on this producer's milk, both raw and pasteurized, and inflation rinses also "raw" and pasteurized, continued low and the pasteurized count relationship to the raw count was fairly normal. Bacteria counts as taken from Jan. 30, 1946, to May 8, 1946, are listed in table 7.

Special attention is called to the relationship existing between rinse counts before and after lye boiling in table 7. Generally the rinse counts made before lye boiling were extremely high. However, bacteria counts made on the milker inflations the days previous to taking milk samples on dates March 5 and 19 were at satisfactorily low levels with 1000 and 3000 recorded, respectively, for the untreated samples and 500 and 1000 for these samples after laboratory pasteurization. Despite these low bacteria counts made on rinses from inflations, the thermoduric bacteria counts were practically equal to counts from the raw milk. This was unlike the result obtained following boiling of inflations in lye solution. Although no samples from cans were taken the day following the lye-boiling treatment, tests made for each succeeding week continued low in the laboratory-pasteurized samples. It was, therefore, thought probable that the two low bacteria counts, secured previous to the boiling treatment, were not a true indication of the condition of the rubber inflations and that the surfaces of the inflations only were relatively free from bacteria. Also, it was thought probable that the pores of the rubber were infected and manifested this by contaminating the milk while flexing the rubber during the milking operation.

Unless a considerable amount of the contamination came from the pores, as well as from the surface of the rubber, it would seem that the milking process would produce a washing effect and would gradually cause a reduction in bacteria count. Since little if any actual progressive reduction took place it was concluded that much of the contamination during the period of high bacteria count was caused by lack of germicidal action in these pores.

Inasmuch as rubber is shown capable of absorbing various quantities of solutions in which it is stored it would appear likely that were sanitizing agents absorbed that would not be detrimental to rubber and would retain germicidal activity in presence of rubber and organic matter, such solutions would be useful for sanitary storage of rubber parts.

Such storage solutions should not be applied in place of proper cleaning, but rather as precaution against contamination from bacteria that are lodged in pores inaccessible to removal by washing treatment.

Since boiling inflations in lye solution proved beneficial in reducing bacterial contamination and removing butterfat from the rubber, such treatment at frequent intervals for all rubber that contacts milk is indorsed. It would appear that bi-monthly or monthly lye boiling treatment is sufficient when accompanied by thorough washing of the milker after each use.

SUMMARY

1. Absorption and deterioration of synthetic rubber milker inflations were studied.
   (a) Synthetic inflations stored in sanitizing solutions were found to absorb various quantities of such solutions during the storage.
   (b) Significantly higher quantities of solutions were absorbed when the inflations were treated by daily working in whole milk for a one-minute period followed by solution storage.
   (c) Inorganic chlorine solutions caused greatest deterioration to synthetic inflations as exhibited by color change, roughening and dissolving conditions on the surface.
   (d) Lowest absorption occurred when lye solution was used for storage.
   (e) A slight tacky feel developed on the surface of inflations stored in acid and the cationic surface-active sanitizing agent, "Roccal."
2. A method for determining absorbed fat is described.
   (a) Highest quantities of fat were absorbed in the mouth or upper portion of inflations.
   (b) The amount of absorbed fat decreased as the lye-boiling period was extended.
3. Effective reduction was shown in number of heat-enduring bacteria by boiling inflations in a strong lye solution.

REFERENCES

(1) FAY, A. C. Preparation, Testing and Use of Chlorine Disinfectants. Kans. Agr. Expt. Sta. Cir. 160: 1–8. 1931.

(2) HART, GEORGE H., AND STABLER, WILLIAM H. Experiment with Practical Application of Heat Sterilization for All Parts of Milking Machines. JOUR. DAIRY SCI., 2: 33–51. 1920.

(3) HENDERSON, J. L., ROADHOUSE, C. L., AND FOLGER, A. The Effect of Heat and Chemical Sterilization on the Rubber Parts of Milking Machines. JOUR. DAIRY SCI., 17: 481. 1934.

(4) JOHNS, C. K. A Simplified Method for Cleaning Milking Machine Rubber Parts. Sci. Agr., 13: 460. (See JOUR. DAIRY SCI., 25: 409.) 1932.

(5) MOIR, G. M. New Zeal. Dairy Exporter. (Cited by Johns, C. K., Longer Life for Milking Machine Inflations. Delaval Monthly, 38(3): 12, 1944.)

(6) PARFITT, E. H. Bacteriological Studies on Cleaning Milking Machines. Purdue Agr. Expt. Sta. Bul. 449. 1940.

(7) STOCKING, W. A., AND MASON, C. J. Milking Machines, Effect upon Quality of Milk. Conn. Agr. Expt. Sta. Bul. 47, pt. 1. 1907.

# A RAPID DIRECT–DISTILLATION METHOD FOR DETERMINING THE VOLATILE FATTY ACIDS OF CHEESE*

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Present-day knowledge regarding total volatile fatty acids of cheese, and particularly in regard to their interrelationship with cheese flavor, is relatively obscure. This lack of knowledge appears to be due, in part, to earlier unsatisfactory quantitative methods for determining these volatile acids.

Simple steam-distillation methods on cheese and other dairy products are now known to give low and variable results. This has been shown by various investigators (1, 4, 7, 8, 9). As a result of their observations on this subject, Hiscox, Harrison, and Wolf (5, 6, 7) developed an involved water-ether extraction method using steam distillation which recovered considerably more of the volatile fatty acids from cheese than did the simple steam-distillation method on cheese mush. Their method, however, has never been widely adopted in this country because of the elaborate and time-consuming technique required and the necessity of using special glass-joined stills of empirical dimensions.

Recently Smiley, Kosikowsky, and Dahlberg (9) published details of a simplified extraction-distillation method which possessed the advantages of being relatively quick, of not requiring special glass-joined stills, and of recovering fully as much of the volatile acids from cheese as the method of Hiscox, Harrison, and Wolf (7). Their method included the principles of ether extraction of an acid-cheese mixture, removal of volatile fatty acids from the ether by washing with dilute alkali, and acidification of the washings followed by direct distillation in the presence of $MgSO_4$. In the meantime, a specific amount of distilled water was added to the acid-residual material and the mixture directly distilled with $MgSO_4$. The sum of the titrations from these two distillations plus that of the alcohol rinse represented the total volatile fatty acidity of the cheese.

In the development of the above method for determining the volatile fatty acids of cheese it was discovered that under certain conditions direct distillation of cheese mush produced results which gave promise of further simplification of the technique.

Distillation of cheese mush, as is commonly used in simple steam distillation methods, fails to fully recover the volatile fatty acids of the cheese. Hiscox and Harrison (5) found this retention to be exercised by the fat and

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protein present, while the work of Smiley, Kosikowsky, and Dahlberg (9) showed that nonvolatile acids, such as palmitic and oleic, also exerted the same effect. It is, however, not improbable that the retentive effect of these cheese constituents could be greatly negated by means of more adaptable distillation techniques. Direct distillation without initial extraction has been used to estimate volatile fatty acids of various substances by a number of workers. Ferris, Redfield, and North (1) were able to recover more volatile fatty acids from butter by direct distillation than by simple steam distillation. Friedemann (2) used a direct distillation method in the determination of volatile fatty acids of biological materials with considerable success.

A successful development of a method involving rapid direct distillation of cheese mush with a minimum of retentive effect should prove to be of considerable importance in cheese or cheese-flavor research. The object of this paper is to present such a method.

## EXPERIMENTAL

*The rapid direct-distillation method.* A 10-gram representative portion of cheese weighed on a torsion balance (sensitivity 4 mg.) was well ground in a mortar with warm 10 per cent sulphuric acid (50–55° C.). The ground cheese mixture was washed quantitatively from the mortar into an 800-ml. Kjeldahl flask with a total of 50-ml. of sulphuric acid solution, including both grinding and washing. A few glass beads and 35 grams of $MgSO_4 \cdot 7\ H_2O$ were added to the Kjeldahl flask. The entire mixture was well shaken and exactly 230 ml. of distilled water at 25° C. were added. Next this acid-cheese mixture was refluxed on a wire gauge square over a low flame for 3 to 5 minutes to drive off carbon dioxide. After slight cooling, exactly 20 ml. of freshly boiled distilled water at 25° C. were used to rinse down the refluxer. The flask was placed on a strongly supported asbestos board $\frac{1}{4}$ inch thick with a 3-inch opening on an ordinary Kjeldahl distillation apparatus, except that the traps were replaced by glass tubes of 10 mm. inside diameter to reduce refluxing to a minimum.

Distillation was begun with the distillate passing through slightly moistened coarse filter paper (S & S 595) of 11 cm. diameter and was continued until a total of 285 ml. distillate had been collected. In some instances it was not possible to collect 285 ml. In this event two other criteria of end point were used, crystallization and temperature reading of the distillation mixture. Crystallization occurred after intense foaming and was detected by a rapid thickening and settling out of the contents. In the case of temperature readings it was found that at the correct end point of the boiling mixture the temperatures ranged from 115° C. to 116° C. (corrected). The temperature should never go over 116° C. and the volume of distillate should not be lower than 280 ml., even with these additional criteria.

During distillation, and particularly near the end, the burners should be opened wide so as to allow a steady flame to cover as much of the exposed bottom surface of the flask as possible, but the flame should not be of such magnitude as to spread beyond this area. A low flame in which the tip or peak of the flame hits a limited area on the bottom of the flask should be avoided to prevent localized burning.

Burning of the contents can be detected by the appearance of a dark purplish discoloration at the surface of the bottom of the flask and can later be confirmed after removal of the flask by a characteristic burnt protein odor. Slight burning did not appear to affect results greatly, but even this ought to be avoided.

In order to accurately estimate the required amount of distillate, a 500-ml. Erlenmeyer flask marked to receive approximately 250 ml. was inserted under the condenser tube. When the distillate reached the 250-ml. mark, this flask was replaced by a 100-ml. graduate. The funnel for the insoluble fraction was also transferred to the graduate. While distillation continued, the distillate in the flask was titrated, then accurately measured in a 300-ml. graduate, and the amount of alkali used was subtracted. The difference between the volume of distillate and the required 285-ml. volume was collected in the 100-ml. graduate and titrated independently. The two titrations were grouped together as the water-soluble portion. Distillates were titrated with N/20 NaOH, using phenolphthalein as indicator. The final results, however, were presented according to standard form as ml. N/10 acid per 100 grams of cheese.

Neutral alcohol (25 ml.) was used to rinse the insoluble acids from the condenser through the filter paper and into a small Erlenmeyer flask. Alcohol rinsings were titrated in a manner similar to that employed with the water distillates. The sum of the titrations of the water distillates and of the alcohol rinse was considered the total volatile acidity of the cheese. Duplicates were run on all samples.

*Analyses of cheeses by the rapid direct-distillation method and by other methods.* The rapid direct-distillation method gave results surprisingly consistent with those obtained on the same cheeses by the method of Hiscox, Harrison, and Wolf (7) and also by the simplified extraction-distillation method of Smiley, Kosikowsky, and Dahlberg (9). Data illustrating this are presented in table 1. It may be noted in this table that 8 distinct types of cheese have been analyzed and that in each instance the rapid direct-distillation method gave results closely approaching those obtained by the other two methods.

As a further test of the effectiveness of this method a series of 60 Cheddar cheeses was analyzed for total volatile fatty acids by the rapid direct-distillation method and by the simplified extraction-distillation method. These cheeses included samples made from raw and pasteurized milk and ranged in

age from 2 days to 3 years. Table 2 shows that there is very good agreement between these two methods on this series of Cheddar cheeses. The rapid direct-distillation method produced a slightly lower total average result for the 60 samples although the difference was within the experimental error of both methods. The average volatile fatty-acid content of the 60 cheeses was 30.1 ml. N/10 acid/100 grams cheese by the simplified extraction-distillation method, while by the rapid direct-distillation method the average value was 29.2 ml. N/10 acid/100 grams cheese or a total average difference of 0.9 ml. N/10 acid/100 grams cheese. On the average, approximately 10 per cent of the total volatile fatty acid value was due to insoluble volatile fatty acids.

TABLE 1

*The volatile acidity of eight different types of cheese as analyzed by the rapid direct-distillation method; the method of Hiscox, Harrison and Wolf; and the simplified extraction-distillation method**

| Cheese | Hiscox *et al.* | Rapid direct-distillation | Simplified extraction-distillation |
|---|---|---|---|
| Blue | 37.5 | 37.0 | 40.4 |
| Switzer | 47.1 | 48.0 | 49.5 |
| Chantelle | 29.9 | 33.4 | 31.4 |
| Sharp ground cheese food | 29.6 | 31.0 | 30.8 |
| Trappist | 51.4 | 47.9 | 49.2 |
| Leiderkrantz | 103.7 | 106.6 | 102.8 |
| Camembert | 39.0 | 38.8 | 39.9 |
| Cheddar | 60.6 | 61.7 | 61.8 |
| Average | 49.8 | 50.6 | 50.7 |

* All values expressed as ml. N/10 acid per 100 grams cheese.

The two methods are about equally accurate in producing checks between duplicate samples, although here again the simplified extraction-distillation method showed a smaller variation between duplicate samples than did the rapid direct-distillation method. For 60 cheeses, the average variation between duplicate samples was 1.32 ml. N/10 acid/100 grams cheese using the simplified-extraction method, whereas it was 1.41 ml. N/10 acid/100 grams cheese by the rapid direct-distillation method.

*Recovery of volatile fatty acids from a mixture containing fat and protein.* Since the rapid direct-distillation method gave results comparable to those produced by the simplified extraction-distillation method, it should recover most of the volatle fatty acids associated with cheese. This recovery is evidently accomplished in spite of the fact that fat and protein are present in the distillation mixture. In order to check this phase more fully, an experiment involving recovery of pure volatile fatty acids under conditions similar to the method was conducted. The volatile fatty acids used ranged from acetic to myristic. It has been shown that acids from butyric to lauric can be fully recovered from water using direct distillation with $MgSO_4$ (9).

Five ml. of N/10 volatile fatty acid were placed in a Kjeldahl flask and titrated with N/20 NaOH. Exactly 2.5 grams of ash-free casein and 3.0 grams of fresh butter oil were next added to the flask. This was followed by the addition of 35 grams of $MgSO_4$ and 270 ml. of distilled water. The mixture was well agitated and brought to pH 2 with a small amount of 50 per

TABLE 2

*The total volatile fatty acids of sixty Cheddar cheeses as determined by the rapid direct-distillation method and the simplified extraction-distillation method**

| Cheese No. | Simplified extraction-distillation | Rapid direct-distillation | Cheese No. | Simplified extraction-distillation | Rapid direct-distillation |
|---|---|---|---|---|---|
| 1 | 34.6 | 34.2 | 31 | 28.2 | 26.0 |
| 2 | 34.7 | 32.8 | 32 | 19.4 | 16.1 |
| 3 | 25.5 | 23.7 | 33 | 23.2 | 21.1 |
| 4 | 19.4 | 21.3 | 34 | 29.2 | 28.5 |
| 5 | 21.1 | 20.3 | 35 | 32.6 | 32.9 |
| 6 | 26.3 | 23.3 | 36 | 40.5 | 36.1 |
| 7 | 24.2 | 22.1 | 37 | 49.4 | 48.0 |
| 8 | 27.5 | 27.6 | 38 | 28.3 | 29.0 |
| 9 | 27.2 | 24.4 | 39 | 40.8 | 42.9 |
| 10 | 33.6 | 32.1 | 40 | 13.7 | 14.9 |
| 11 | 26.1 | 26.0 | 41 | 16.8 | 17.5 |
| 12 | 30.0 | 26.5 | 42 | 24.0 | 21.1 |
| 13 | 35.8 | 34.8 | 43 | 24.0 | 20.9 |
| 14 | 34.6 | 33.5 | 44 | 25.0 | 22.8 |
| 15 | 34.8 | 33.8 | 45 | 21.7 | 20.2 |
| 16 | 61.4 | 61.7 | 46 | 18.8 | 17.1 |
| 17 | 12.7 | 12.0 | 47 | 25.8 | 25.1 |
| 18 | 14.5 | 13.4 | 48 | 35.1 | 35.3 |
| 19 | 13.5 | 11.0 | 49 | 41.2 | 40.3 |
| 20 | 13.8 | 12.2 | 50 | 206.0 | 209.4 |
| 21 | 14.7 | 13.9 | 51 | 41.1 | 39.4 |
| 22 | 16.5 | 14.7 | 52 | 19.5 | 21.2 |
| 23 | 11.8 | 12.6 | 53 | 21.4 | 21.8 |
| 24 | 17.4 | 17.3 | 54 | 21.1 | 21.3 |
| 25 | 18.9 | 16.6 | 55 | 22.0 | 22.0 |
| 26 | 16.3 | 14.1 | 56 | 30.0 | 30.4 |
| 27 | 24.8 | 20.0 | 57 | 18.6 | 17.4 |
| 28 | 16.5 | 12.1 | 58 | 31.3 | 30.8 |
| 29 | 21.1 | 21.9 | 59 | 25.8 | 25.8 |
| 30 | 90.2 | 94.7 | 60 | 30.9 | 31.9 |
| Average of 60 cheeses | | | | 30.1 | 29.2 |

* All values expressed as ml. N/10 acid per 100 grams cheese.

cent $H_2SO_4$ and then refluxed for 5 minutes. The refluxer was rinsed with 20 ml. of distilled water. Distillation of the mixture was begun on the slightly modified Kjeldahl apparatus and was continued until 285 ml. of distillate were recovered. This distillate and the neutral alcohol rinsings containing the insoluble volatile fatty acids were titrated with N/20 NaOH. After compensating for blanks the percentage recovery was calculated. These data are presented in table 3.

TABLE 3

*The recovery of pure volatile fatty acids by direct distillation with $MgSO_4$ from a mixture containing fat and protein*

| Fatty acid | Recovered in presence of 2.5 grams casein and 3.0 grams butter oil |
|---|---|
| | *per cent* |
| Acetic ($C_2$) | 98 |
| Butyric ($C_4$) | 97 |
| Caproic ($C_6$) | 97 |
| Caprylic ($C_8$) | 90 |
| Capric ($C_{10}$) | 79 |
| Lauric ($C_{12}$) | 46 |
| Myristic ($C_{14}$) | 17 |

It is evident from this table that for the short-chain volatile fatty acids, such as acetic, butyric, and caprylic, recovery was close to 100 per cent, but for the long-chain volatile fatty acids a definite retentive effect was exerted by the butter fat and protein combination. The retentive effect was in direct relation to the number of carbon atoms in each fatty acid. As the short-chain fatty acids are the most important in cheese (10), the retentive effect should not prove to be of much consequence in regard to the method. These results approximated closely those obtained by Smiley, Kosikowsky, and Dahlberg (9) on the recovery of volatile fatty acids in the presence of palmitic and oleic acids under similar conditions of distillation.

*The temperature of distillation.* A reason for the more effective recovery of the volatile fatty acids by the new method would undoubtedly be the fact that a definite increase in the temperature of the boiling mixture

TABLE 4

*The temperature of the distillation mixture and the gas phase above it at various periods in the distillation process and the resulting amount of volatile fatty acid recovered*

| Portions of distillate | Titration for volatile acids | Temperature in distillation mixture | Temperature in gaseous phase |
|---|---|---|---|
| *ml.* | *ml.** | *°C.* | *°C.* |
| 1st drop over | ..... | 102.0 | 99.8 |
| 50 | 7.5 | 102.7 | 99.8 |
| 50 | 6.8 | 102.9 | 99.8 |
| 50 | 6.8 | 103.5 | 99.9 |
| 50 | 7.0 | 104.0 | 99.9 |
| 50 | 8.3 | 106.0 | 100.0 |
| 10 | 2.3 | 107.2 | 100.0 |
| 10 | 2.5 | 109.5 | 100.0 |
| 10 | 2.5 | 113.0 | 100.5 |
| 5 | 1.5 | 115.7 | 100.8 |
| Alcohol rinse ..... | 2.8 | ..... | ..... |
| Total ..... | 47.8 | ..... | ..... |

* Ml. N/10 acid/100 grams cheese.

occurs during distillation. Friedemann (2) used the soluble salt $MgSO_4$ to raise the boiling point during direct distillation of volatile fatty acids in biological materials. The rapid direct-distillation method also required the use of $MgSO_4$.

Temperature changes occurring in the distillation mixture and the gaseous phase above it were observed during an actual analysis on a sample of cheese. From the first 250-ml. portion of distillate, 50-ml. quantities were collected independently and titrated, and at the same time the temperatures were noted at the time each portion was collected. At the very end of the distillation, portions were collected n 10-ml. and 5-ml. amounts.

It can be seen in table 4 that there was a gradual rise in the temperature of the boiling mixture during the distillation of the first 250-ml. portion. During the recovery of the last 35-ml. portion there was a rapid acceleration in temperature. The maximum temperature attained in the boiling mixture for this trial was 115.7° (corrected) while for the gaseous phase the maximum temperature was 100.8° C. (corrected). These maximum temperatures were maintained for about one minute. Other trials on various cheeses gave results of approximately the same magnitude.

The value of 47.8 ml. N/10 acid per 100 grams of cheese here was almost identical to the value obtained on the same cheese using the simplified extraction-distillation method.

*Hydrolysis or decomposition of the cheese constituents under conditions of the method.* The possibility that hydrolysis or decomposition of the cheese constituents might occur and result in the production of volatile substances was considered. Gould (3) has shown that heating skim milk in cans at 116° C. for 1- and 2-hour periods appreciably increased the volatile acid content of the milk as determined by steam distillation. Lactose by its subsequent destruction was considered as being the compound most responsible for this increase.

As most ripened cheeses usually have lost all the lactose by bacterial fermentation in a few days after making, the findings of Gould (3) apparently are not applicable in this case. Gould (3), also maintained his temperature of 116° C. for a much longer period than was required by our method. Nevertheless, an investigation was conducted to note if any hydrolysis or decomposition occurred under conditions of the method.

Specific quantities of fresh butter oil, purified casein, and lactose in various combinations were mixed with 50 ml. of 10 per cent $H_2SO_4$ brought up to the desired amount with water, followed by the distillation procedure outlined for the method. At the same time the steam distillation technique of Hiscox, Harrison, and Wolf (7) was also applied.

Table 5 shows the effect of the distillation procedure on fat, and fat and casein. The distillate was titrated in small portions in order to determine if definite increases in volatile acidity occur near the end of the distillation

where the temperature had increased. The fact that no exaggerated increases appeared at this point and that all the blanks were low and checked well with those obtained by the method of Hiscox, Harrison, and Wolf (7), where lower temperatures of distillation were used and where fat and casein were not involved, pointed to the conclusion that no apparent hydrolysis or decomposition occurs during the operation of this method.

When pure lactose was used alone or in combination with casein, a small blank was also obtained. The blank obtained for the distillate from 5 grams

TABLE 5

*The titration blanks obtained on fresh butter oil and ash-free casein using the rapid direct-distillation technique and the extraction method of Hiscox, Harrison, and Wolf* (7)

| 2.5 gm. casein + 4.4 gm. butter oil | | 4.4 gm. butter oil | |
|---|---|---|---|
| Distillate portions | Titration | Distillate portions | Titration |
| *ml.* | *ml. N/10 acid** | *ml.* | *ml. N/10 acid* |
| Rapid direct-distillation method | | | |
| 50 | 0.03 | 50 | 0.03 |
| 50 | 0.03 | 50 | 0.03 |
| 50 | 0.03 | 50 | 0.03 |
| 50 | 0.06 | 50 | 0.04 |
| 50 | 0.08 | 50 | 0.03 |
| 10 | 0.03 | 10 | 0.03 |
| 10 | 0.03 | 10 | 0.04 |
| 10 | 0.03 | 10 | 0.03 |
| 10 | 0.03 | 10 | 0.03 |
| 3 | 0.02 | 6 | 0.04 |
| Alcohol rinse | 0.06 | Alcohol rinse | 0.07 |
| Total | 0.43 | | 0.37 |
| Method of Hiscox, Harrison, and Wolf | | | |
| Total | 0.40 | | 0.28 |

* 0.03 ml. represented 1 drop from burette.

of lactose was 0.12 ml. N/10 acid, and when 5 grams of lactose were mixed with 2.5 grams of casein the resulting titration for the distillate was only 0.40 ml. N/10 acid. In view of the fact that distillation with plain water usually gave a blank value of 0.10 ml. N/10 acid, this was a rather good indication that lactose, either alone or in combination with protein, was not greatly affected by the temperature under the conditions of the method.

## DISCUSSION

The rapid direct-distillation method presented here possesses several distinct advantages. It recovers fully as much of the volatile fatty acids of cheese as are recovered by the method of Hiscox, Harrison, and Wolf (7) or by the simplified extraction-distillation method (9). This is accomplished without the use of special glass-stills and with a minimum of analytical ap-

paratus and chemical reagents. The new method also possesses the advantage of being very timesaving. This is more clearly illustrated by the fact that the method of Hiscox, Harrison, and Wolf (7) requires approximately 40 hours to complete an individual analysis; that by the simplified-extraction method of Smiley, Kosikowsky, and Dahlberg (9) about 4 hours are required; while by the rapid direct-distillation method this time requirement is reduced to approximately 80 minutes.

It is not believed that this method should supplant the simplified extraction-distillation method at all times, for there may be circumstances when ether extraction would be desirable. Also, although the rapid-distillation method appears quite dependable from the standpoint of producing duplicate results, the simplified-extraction method appears from a comparative study of available data to be slightly more accurate and consequently could be used as a check method. Although greater care is required to reach a proper end point by the rapid direct-distillation method, it appears very well suited to a situation where a large number of cheese samples are to be analyzed over a short period of time with a good degree of accuracy.

Initially in the development of the method ortho phosphoric acid was first used as the solvent but it became apparent after a series of analyses that for some reason recovery was not so complete as that obtained by the simplified extraction-distillation method. When 10 per cent $H_2SO_4$ was substituted for 10 per cent $H_3PO_4$ more complete recovery was attained and the results checked well with those obtained by the simplified extraction-distillation method. As a cheese solvent, 10 per cent $H_2SO_4$ appeared to be as effective as 10 per cent $H_3PO_4$.

Direct distillation under conditions of the new method recovered quite completely the lower-chain volatile fatty acids from a mixture of fat and protein. As these acids are the ones mostly associated with ripened cheeses this high percentage of recovery emphasizes the fact that the method should produce results comparable to other standard methods. The reason for this effective recovery is probably largely due to the higher boiling point reached in the distillation mixture of higher specific gravity.

There was no evidence that partial hydrolysis or decomposition occurred in the mixture during distillation under conditions of the method.

The precautions necessary to this method require emphasis. In weighing out samples for a test the cheese has to be cut up into small particles and be well mixed. Duplicate samples should always be taken from the same pile of well-mixed cheese.

In this method distillation should normally proceed until complete crystallization of the contents occurs. However, due to the turbid nature of the mixture, it is quite difficult to accurately determine crystallization as an end point. Consequently the use of a measured volume of distillate (285 ml.) is recommended. This amount of distillate under normal circum-

stances should carry the distillation mixture very close to complete crystallization. However, in a few instances it may not be possible to collect exactly this amount before crystallization occurs, and, if distillation is carried further in the attempt to collect the desired amount, burning will follow which may result in higher results. In this case crystallization of the contents or temperature reading may be employed as a criterion of end point. Crystallization usually follows a period of intense foaming and is detected by a rapid thickening and settling of the distillation mixture. Burners should be turned off immediately at this point. The temperature of the distillation mixture at the correct end point ranges from 115 to 116° C. (corrected). Temperatures over 116° C. should be avoided. Even with these two additional criteria the amount of distillate collected should not be less than 280 ml.

A steady full flame directed so as to cover the general area of the exposed bottom surface of the flask is required. Application of a low flame so as to contact a very limited area of the flask bottom should be avoided as this seems to encourage local burning near the very end of distillation. However, at no time should the flame be allowed to go beyond the bottom area of the flask limited by the 3-inch asbestos board opening. Tight fittings of the flasks in their asbestos sockets are necessary.

The distillation condenser tubes should be washed periodically with neutral alcohol and distilled water, and the alcohol should be checked frequently for neutrality.

## SUMMARY

A very short and rapid method for the determination of volatile fatty acids in cheese is presented. This new method required that a finely ground sulphuric acid–cheese mixture with a low pH be refluxed to drive off $CO_2$ and directly distilled in the presence of $MgSO_4$. A specific quantity of water (250 ml.) was added prior to distillation and the amount of distillate recovered was limited to 285 ml. The insoluble volatile fatty acids were washed from the condenser tube by neutral alcohol. Distillates were titrated with N/20 NaOH, using phenolphthalein as indicator. The sum of the titrations of the water distillate and the alcohol rinse represented the total volatile acidity of cheese.

The advantages of this method are that high recovery of the volatile fatty acids from cheese is accomplished in a very short time without the use of special glass-joined stills and with a minimum of apparatus and chemical reagents. This method is very adaptable to circumstances where large numbers of cheeses need to be tested in a short time.

Direct distillation in the presence of $MgSO_4$ brought about a very effective recovery of pure lower-chain fatty acids when fresh fat and casein were in the mixture. Under these conditions, recovery was indirectly related to the number of carbon atoms present in each fatty acid.

## REFERENCES

(1) FERRIS, L. W., REDFIELD, H. W., AND NORTH, W. R. The Volatile Acids and the Volatile Oxidizable Substances of Cream and Experimental Butter. JOUR. DAIRY SCI., **4**: 521–535. 1921.

(2) FRIEDEMANN, T. E. The Identification and Quantitative Determination of Volatile Alcohols and Acids. Jour. Biol. Chem., **123**: 161–184. 1938.

(3) GOULD, I. A. The Formation of Volatile Acids in Milk by High Temperature Heat Treatment. JOUR. DAIRY SCI., **28**: 379–387. 1945.

(4) GOULD, I. A., AND JOHNSON, B. C. Solubility and Volatility of Fatty Acids Involved in Lipolysis in Homogenized Raw Milk. JOUR. DAIRY SCI., **27**: 173–180. 1944.

(5) HISCOX, E. R., AND HARRISON, J. Volatile Acids of Cheese. I. Retentive Power of Cheese and Its Constituents. Jour. Dairy Res., **9**: 215–226. 1938.

(6) HISCOX, E. R., HARRISON, J., AND WOLF, J. Z. Volatile Acids of Cheese. II. Methods of Extraction. Jour. Dairy Res., **9**: 227–232. 1938.

(7) HISCOX, E. R., HARRISON, J., AND WOLF, J. Z. Volatile Acids of Cheese. III. Application of the Extraction Method. Jour. Dairy Res., **12**: 155–169. 1941.

(8) MARQUARDT, J. C., AND DAHLBERG, A. C. More Accurate Determination of Volatile Fatty Acid and Other Changes as a Means to Study Cheddar Cheese Curing. JOUR. DAIRY SCI., **23**: 518–519. 1940.

(9) SMILEY, K. L., KOSIKOWSKY, F. V., AND DAHLBERG, A. C. A Simplified Extraction-Distillation Method for the Determination of the Volatile Fatty Acids of Cheese. JOUR. DAIRY SCI., **29**: 307–315. 1946.

(10) SUZUKI, S. K., HASTINGS, E. G., AND HART, H. B. The Production of Volatile Fatty Acids and Esters in Cheddar Cheese and Their Relation to the Development of Flavor. Wis. Res. Bul. 11. June, 1910.

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# ABSTRACTS OF LITERATURE

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## MILK AND MILK PRODUCTS

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The Royal Technical College, Copenhagen, Denmark

United States Department of Agriculture

# ABSTRACTS OF LITERATURE

## BUTTER

**408. Essentials to the Improvement of the Quality of Cream.** F. W. HAMILTON. Canad. Dairy and Ice Cream Jour. *25*, 5:33. July, 1946.

The problem is the production of better raw cream. This can be accomplished by (1) increase in production of butterfat per acre, (2) healthy cows properly fed and cared for in clean surroundings, (3) proper cooling of the cream and (4) handling in sterilized utensils. Greater volume and more profitable production means better quality. Standards for sanitary production must be established. For marketing of cream to creameries a cream producer should meet the following requirements: (1) he must be fully aware that he is producing a food for human consumption, (2) only healthy cows be maintained in the milking herd, (3) stables with cement flooring and adequate drainage and lighting be provided, (4) a separate building or room be provided for separating of milk and storage of utensils, (5) that adequate means of cooling cream be provided and maintained, (6) the milk utensils and cream separator be maintained in a clean sanitary condition. H.P.

**409. New Dairy Products Developed by Necessities of War.** MEL PRATT. Canad. Dairy and Ice Cream Jour., *25*, 9:37. September, 1946.

A palatable new butter known as "Butter concentrated hardened" has been developed for use in tropical conditions. At a temperature of 105° F. it can be spread on bread as ordinary butter would be. It consists of dry butterfat containing 3 per cent hydrogenated peanut oil, 4 per cent skim milk powder, 2 per cent salt, and 0.2 p.p.m. diacetyl. A new cheese known as homo cheese was developed that kept for six days at 145° F. Dry butterfat was manufactured in great quantities and kept well for 12 months or more. "Tropical Spread" was developed for the army for use in tropical areas. It contained 1% salt, 2% spray dried skim milk powder, 77% dry butterfat and 20% hydrogenated butterfat. Peanut oil was later substituted for the hardening agent when it became available. Other developments are the modification of the phosphatase test to cheese, the method of packaging cheddar cheese in valve-vented cans, the packing of cheese in transparent moisture proof sheets producing rindless cheese, dehydrating and compressing cheddar cheese and army cheese spread. H.P.

**410. The Use of Indicator Paper to Determine the pH of Butter.** A. H. WHITE. Canad. Dairy and Ice Cream Jour., *25*, 8:23. August, 1946.

The pH values of the cream, buttermilk and butter serum as shown by

the indicator paper were lower than the pH of the butter serum by the glass electrode. As the pH of butter serum increased, the variation between the values obtained by the paper and the glass electrode became greater. Dilution of the butter serum with distilled water increased the pH as determined by the indicator paper and glass electrode. The data indicate that pH indicator papers do not give reliable pH values for cream, buttermilk, or butter serum when compared to the pH of butter serum by the glass electrode. Creamerymen should base their neutralizing practices on an accurate titration test for acidity rather than on pH values determined by an indicator paper. H.P.

**411. Dosage de la Matière Grasse des Cremès. (Determination of the Fat Content of Creams.)** PAUL CODOR AND PIERRE MACHEREL. Le Lait, *24*, No. 237–238: 196, and No. 239–240: 289. 1944.

All rapid tests for fat in cream utilizing a 5-cc. sample must take into account that the final butyrometer reading must be corrected because the cream density varies with its fat content. Acidity also influences the weight of sample taken. This problem is treated mathematically with reference to two types of butyrometers. The calibration of glassware is reported on and an improved mechanism for reading tests is illustrated and described. O.R.I.

**412. The Importance of Volume in the Creamery Business.** P. E. REED. Canad. Dairy and Ice Cream Jour., *25*, 5: 38. July, 1946.

Large creamery unit production reduces cost and invariably turns out a better quality of butter. Better equipment and closer supervision are maintained in larger plants. H.P.

## CHEESE

**413. Control of Insects in Cheese and Butter Factories.** R. W. THOMPSON. Canad. Dairy and Ice Cream Jour., *25*, 5: 27. May, 1946.

Several insects found in creameries and cheese factories became sufficiently abundant to necessitate control measures. These include the common housefly, cockroaches, cheese mites, cheese skippers, larder beetles, and their larvae. Control measures to take on flies are (1) to prevent breeding, (2) to prevent spillage of milk or whey, (3) to keep the flies out of the building itself, (4) destroy flies that get in the building daily with DDT. The German cockroach occurs in some Canadian creameries. They can be controlled by use of a sodium fluoride-pyrethrum powder mixture as a dust with repeated treatments. Cheese mites and cheese skippers are the two worst pests found in cheese. Cleanliness is of great importance in keeping mites under control. Hot water (over 150° F.) and formaldehyde are

effective in killing mites. Low-temperature storage is an excellent safeguard against mite damage. Fumigation with methyl bromide in conjunction with carbon dioxide is satisfactory in an airtight chamber above 60° F. for 24 hours. The cheese skipper attacks cheese, ham, bacon, and beef. The adults may be excluded from storage by a 30-mesh wire screen, but the low temperature controls given for mites are the most effective since reproduction cannot continue at temperatures below 56° F. Fumigation is also effective (as for mites). Larder beetles can be controlled by fumigation if heavily infested. H.P.

**414. Influénce de L'Elimination de la Croute dans L'Analyse des Fromages. (Influence of Eliminating the Rind in the Analysis of Cheese.)** JEAN PIEN. Le Lait, *24*, No. 237–238 : 210. 1944.

The composition of the rind of cheese differs from the interior of the cheese either because of loss of moisture or the action of molds, yeasts, and proteolytic bacteria during ripening. Moisture and fat determinations were made of the rind and of the interior of several types of cheese while fresh as well as partially and fully ripened. Camembert, Brie, Port Salut, and Edam were included in the study. The percentage of fat in the water-free substance was calculated in each case.

The rind of the soft cheese was sometimes drier than the interior when the cheese was new and was always so when the cheese was cured. The fat in the water-free substance was lower in the rind of soft, young cheeses due to the action of molds, but became higher than the interior after aging. This is apparently due to the more rapid loss of volatile nitrogenous matter from the rind than from the interior.

In the case of pressed cheeses such as Edam, the rind is always drier than the interior and becomes more so as ripening progresses. In the majority of cases the fat in the water-free substance is slightly higher in the rind than in the interior.

Results were compared in cases where the rind was eliminated and where it was included. For fresh and semi-cured soft cheese no regular effect was noted, but in the case of fully cured soft cheese eliminating the rind resulted in higher moisture values and lower values for fat in the water-free substance. In the case of the harder cheeses, the moisture values were much higher where the rind was eliminated. The effect of this procedure on the values for fat in the water-free substance was variable. O.R.I.

**415. Les Bases Techniques de la Définition Légale et de la Fabrication des Fromages. (The Technical Bases for the Legal Definition and the Manufacture of Cheese.)** JEAN PIEN. Le Lait, *24*, No. 241–243 : 1. January–March, 1945.

A series of 29 formuluae are given, together with examples, illustrating

how one may calculate the fat, solids, solids-not-fat, and the percentage recovery of the constituents in cheesemaking providing the requisite analytical data are at hand. Of particular interest is the "coefficient K" which indicates the weight of solids-not-fat recovered in the cheese per liter of mixed milk used. This coefficient is indicative of plant efficiency. It is suggested that the various formulae will be of value in establishing normal yields and for price fixing purposes. O.R.I.

**416. Influence of Temperature on the Curing of Cheddar Cheese.** H. C. HANSEN. Canad. Dairy and Ice Cream Jour., *25*, 6: 48. June, 1946.

Raising the cheese ripening temperature from 40° F. to 60° F. increased the loss of weight from 4.44% to 8.71% during six months storage. Cheddar cheese ripened at 40° F. for 6 months was usually criticized for being slightly acid, lacking in flavor or flat. Cheese ripened at 50° F. was high acid, bitter, or very slightly fruity. Cheese cured at 60° F. was high acid, sharp or slightly fruity. Cheddar cheese made from good milk developed more flavor in three months at 60° F. than did cheese cured at 40° F. and 50° F. for 6 months. Cheddar cheese made from good quality raw milk developed more flavor in a shorter time than did cheese made from pasteurized milk, but it was not as uniform in flavor. H.P.

**417. Effect of Varying Amounts of Salt on the Quality of Cheddar Cheese.** E. B. TUSTIN, JR., Worcester Salt Co., Natl. Butter and Cheese Jour., *37*, 9: 44. September, 1946.

Weak, pasty body, open texture, abnormal ripening, and greater shrinkage during curing are all associated with under-salting of cheese. Over-salting causes dry, harsh body, cracking of the cheese rind, excessive mold damage, and discoloration in colored cheese. Salt should be added in small quantities and thoroughly stirred between each addition. Holding salted curd in the vat for about 20 minutes before hooping is desirable. For every 1,000 pounds of milk containing approximately 3.5% fat there should be added to the curd 1 pound of salt for every 1% of salt desired in the curd. Variations above or below this proportion must be made to conform to the cheese-yielding capacity of the milk and quality of the curd. It is never advisable to add less than 2% salt to curd; 2½% is most satisfactory for normal curd. W.V.P.

## CONCENTRATED AND DRY MILK: BY-PRODUCTS

**418. L'analyse Chimique des Colles en Poudre à Base de Caseine. (Chemical Analysis of Casein-Based, Powdered Glues.)** J. PIEN and G. RENVOISE. Le Lait, *25*, 244–246: 121. 1945.

Casein glues vary greatly in composition and properties. In addition to

casein, such materials as gelatin, dextrin, chalk, calcium and sodium carbonates, sodium fluoride, sodium silicate, and many other inorganic substances may be present. Methods of analyses are given which include separation of organic and inorganic materials, as well as the qualitative and quantitative methods for these. A convenient and fairly accurate method of separating constituents consists of shaking 10 grams of powdered glue in 100 ml. of chloroform. The organic matter can then be decanted. If gelatin is present it will dissolve in tepid water. Dextrin can be detected by the iodine reaction. Recognized methods of inorganic analysis are employed for further elucidation. Examples are given showing the accuracy of the method when applied to samples of known composition.

O.R.I.

## DISEASE

**419. The Efficacy of the Microscope Examination of the Incubated Producer Milk Samples in Detecting Streptococcic Mastitis in Dairy Herds.** H. P. JOHNSON, City Health Dept., Lansing, Mich., AND C. S. BRYAN, Mich. Agr. Expt. Sta., East Lansing, Mich. Jour. Milk Technol., *9*, No. 4: 197–201: 248. July–August, 1946.

Individual samples of milk were checked for streptococcic mastitis on 863 cows in 83 herds. The examination showed 78.3 per cent of the herds and 21.9 per cent of the cows were infected.

Producer samples were also collected on the same day from each of the dairy herds and examined microscopically, following incubation. The results are summarized as follows:

1. In 60 herds a positive producer sample showed accurately the presence of streptococcic mastitis, as shown by the examination of individual cow samples from each herd.

2. In 4 herds positive producer sample results were not verified on examination of cow samples. The possibility of contamination from previous infected samples is suggested, since they were taken from the weigh tank. If the producer samples were collected from the cows, this contamination may be reduced to a minimum.

3. In 5 herds a negative producer was not confirmed upon examination of the individual cow samples, because in 4 herds one infected cow was found and in the fifth herd two were located. No explanation is offered for these results.

4. The remaining 14 herds negative producer samples showed freedom from infection as confirmed by the results of individual cow testing.

H.H.W.

## FEEDS AND FEEDING

**420. Milking for Profit Requires Good Pasture, Feed and Care.** D. H. McCallum. Canad. Dairy and Ice Cream Jour., *25*, 7 : 38. July, 1946.

Two methods of increasing returns are (1) to receive a higher price for the commodity produced and (2) to reduce the cost of production. To increase profit it is necessary to increase production per cow, selection and weeding through cow testing, better use of pastures, wise grain feeding, more efficient use of labor, prevention of disease, and producing a good quality product. H.P.

**421. Dried Whey as a Substitute for Dried Buttermilk in Chick Rations.** S. J. Slinger, F. N. Marcellus, and E. V. Evans, Ont. Agr. College, Guelph, Ontario. Sci. Agr. *26*, No. 8 : 381–387. August, 1946.

"Dried Whey" in amounts up to 8 to 10 per cent was used satisfactorily in rations for growing chicks to replace part of the dried buttermilk when the necessary adjustments were made in the riboflavin and protein levels of the ration. Higher levels of dried whey, 12 to 20 per cent, resulted in the onset of an oedematous condition, although growth, as judged by weight and mortality, was little, if any, affected. This condition was accompanied by an increased water consumption and the external symptoms gradually disappeared.

"Although the quantity of dried buttermilk necessary for growth appears to be small, there is some indication in this work that it should not be completely replaced by dried whey. There is also a suggestion that dried whey may contain some essential growth factor or factors not present in dried buttermilk." O.R.I.

## FOOD VALUE OF DAIRY PRODUCTS

**422. Les Substances Choliniques du Lait. (The Choline Substance of Milk.)** E. Kahane and Mlle. J. Levy. Le Lait, *25*, 247–248 : 193–223. 1945.

An extensive study is reported of the choline content of cows' milk with some values reported for ewes' milk as well. Details are given of the analytical methods, which include treatment of the milk with ferric sulfate and calcium carbonate to produce a clear filtrate, the latter being evaporated to dryness and then redissolved quantitatively in water. Free choline is then determined by the disappearance of the Florence reaction (microscopic observation for crystals of choline periodide).

In addition to free choline the filtrate contains a substance or group of substances distinct from the phosphoaminolipids which furnish an acid-hydrolyzable choline. This is determined on an aliquot of the filtrate by refluxing with concentrated hydrochloric acid. Extraction of the total choline is done by treating the original milk sample with 65% sulfuric acid for 24 hours at 105° C. Non-hydrolyzable choline was determined by differences.

Average results on 100 samples of cows' milk showed choline present in the form of free choline and hydrolyzable combined choline at from 15 to 35 mgm./l. Variations could not be correlated with such factors as season, feed, breed, age or stage of lactation except that free choline was greatly reduced at calving.

Values for total choline were much more constant ranging between 160 and 280 mgm./l. with an average of 222 mgm. Milk enzymes are apparently inactive with respect to the conversion of choline from one form to another.

There appeared to be no close relationship between choline and the fat globules, choline being largely recovered in the skim milk fraction and equally as rich in the fore-milk as the strippings. Sheeps' milk contained somewhat less free and total choline than did cows' milk. O.R.I.

## ICE CREAM

**423. Scientists Develop New Sugar.** ANONYMOUS, Ice Cream Field, *48*, 3: 35. September, 1946.

A method of extracting levulose—a sugar 50 per cent sweeter than sucrose—has been developed by the University of Colorado Engineering Experiment Station at Boulder, Colorado, according to an announcement by Dr. Robert C. Hackett, Scientific Director of the Sugar Research Foundation. The method was developed by M. M. Reynolds, Junior Research Engineer, while working with Dr. Carl W. Borgmann, Director of the University of Colorado Experiment Station, and is sponsored by the Sugar Research Foundation.

Briefly the process is as follows: Sucrose is hydrolyzed by acid and the levulose precipitated with lime. Then after filtering, the lime is precipitated by bubbling carbon dioxide through the solution and freeing levulose which then dissolves. After concentrating the levulose by evaporating part of the water the sugar is crystallized in a hand ice cream freezer during slow stirring.

It is stated that about 100 pounds of levulose has been made by this process. Expectations are that additional studies will be made to estimate costs and solve technical manufacturing problems. W.C.C.

**424. Strong Arm Dipping—Improper Cabinet Temperatures Cause Heavy Loss.** ANONYMOUS, Ice Cream Field, *48*, 2: 30. August, 1946.

The importance of controlling ice cream dipping temperatures is emphasized. It is stated that temperatures below 10° F. or above 16° F. will result in loss of time or overrun. It is mentioned, however, that authorities do not agree on the optimum dipping temperatures—some prefer 10 to 12° F. while others claim 5 to 8° F. give best results. W.C.C.

**425. Storing Ice Cream Ingredients for Short Supply Use.** R. J. RAMSEY, Canad. Dairy and Ice Cream Jour., *25*, 9: 46. September, 1946.

It is necessary to store butterfat and milk solids-not-fat because of fluctuation in seasonal production of milk. The following products are discussed, with the best method of manufacture and storage listed: (1) frozen cream, (2) plastic cream, (3) butter, (4) butteroil, (5) sweetened condensed skim milk, (6) frozen plain, (7) condensed milk, (8) spray skim milk powder, (9) roller process powder. H.P.

**426. Treating Nuts for Ice Cream.** C. A. IVERSON, Head, Dairy Department, Iowa State College, Ames, Iowa. Ice Cream Field, *48*, 2: 22. August, 1946.

Recipes are given for making buttered pecan, English walnut, black walnut, hazelnut, cashew, or pinon or pignolia, and pistachio. All recipes are similar to the one for buttered pecan which follows:

Dry roast 8 pounds pecans until brown throughout the nut, then cool quickly. Heat 1½ pounds of butter to 330° F. (160° C.). Add roasted nuts and one ounce of salt. After few minutes drain off butter. Add 5 pounds buttered nuts to 10 gallons of finished ice cream. W.C.C.

## MILK

**427. Cost of Producing Milk.** L. C. CUNNINGHAM, Professor of Farm Management, Department of Agricultural Economics, New York Agricultural Experiment Station. Ice Cream Field, *48*, 3: 46. September, 1946.

The author gives results of cost studies made in various parts of the State of New York. He states that the average feed and labor requirements per 100 pounds of milk equal 34 pounds of grain, 77 pounds of hay, 114 pounds of silage and 2.6 hours of man labor. Based on $75.00 a ton for dairy ration, $15.00 a ton for hay, $6.00 a ton for silage and $.55 per hour for labor, the cost of producing 100 pounds of milk is estimated by formula to be $4.35. If the labor cost were $.65 per hour it would amount to $4.61 per hundredweight.

It is also pointed out that the change in actual cost of $2.07 per hundredweight in 1939–40 to the current, estimated cost by formula of $4.35 represents an increase of 114 per cent.

The author states "Although it is cheaper to produce milk in the pasture season than it is in the winter season, it does not follow that the year-round cost of producing 100 pounds of milk is lower in summer dairies than in winter dairies." This indicates that the reverse is often true.

The author concludes,

"High production per man was obtained mainly by these practices: (1) keeping moderately large herds which made possible (2) spending less than the average amount of time per cow to do the chores in the stable, yet (3) having better-than-average producing cows." W.C.C.

**428. Un Nouveau Butyromètre Pour L'Application de la Méthode Gottlieb-Röse. (A New Butyrometer for Application of the Röse-Gottlieb Method.)** JEAN PIEN, Laboratories de la Laiterie des Fermiers Reunis. Le Lait, *24*, No. 239–240: 341. October–December, 1944.

A special extraction flask claimed to be superior to the Rieter and Rohrig tubes is illustrated and described. The flask is a straight, glass-stoppered tube with expanded portions at the base, center and top and cubic centimeter graduations on the upper and lower necks. Immediately above the lower graduation is a side-arm and glass stopcock. A 10-ml. sample of milk is used. The flask is claimed to permit easier and more accurate separation of the ether fraction. O.R.I.

**429. Le Calcul de L'Extrait Sec du Lait. (Calculation of the Total Solids Content of Milk.)** E. MULLER-HOESSLI, Laboratoire Contonal de Schaffhouse. Le Lait, *24*, No. 239–240: 310. October–December, 1944.

Halenke and Moslinger have suggested the following formula for estimating the total solids content of milk.

$$\text{T. S.} = \frac{(\text{Fat} \times 5) + \text{Density}}{4}$$

This gives results slightly lower than the Fleischman formula and the author proposes the following modification of the Halenke-Moslinger formula:

$$\text{T. S.} = \frac{(\text{Fat} \times 4.8) + \text{Density}}{4} + 0.26$$

Results on 27 samples indicate that this modification gives values very similar to those obtained by the Fleischman formula. (The values used as densities are apparently Quevenne lactometer values.) O.R.I.

**430. Causes of Variations in the Butterfat Content of Milk.** V. E. Graham. Canad. Dairy and Ice Cream Jour., *25*, 6: 34. June, 1946.

The factors operating over long periods are: (1) age of cow, (2) influence of season, (3) influence of stage of lactation, (4) combination of long time factors. The factors causing short-time variations are: (1) night and morning milk, (2) temperature, (3) excitement, (4) fatness of the cow at calving time. The author states that (1) milk varies in fat test to a greater extent than is generally realized, (2) any variation in the fat test of the milk will cause a change many times as great in the fat test of the cream separated from it, (3) morning milk usually has a lower fat test than evening milk, (4) excitement and sudden changes in temperature are common causes of sudden variations in fat test, (5) if most of the cows freshen in the spring, the lower test due to the seasonal factor will coincide with the lower test due to the stage of lactation, (6) feed has a marked influence upon the color of milk but the fat test of milk cannot be consistently increased by the use of specific feeds. H.P.

**431. Research on Rancidity in Milk Greatly Advanced Since 1726.** W. L. Dunkley. Canad. Dairy and Ice Cream Jour., *25*, 6: 27. 1946.

A bitter flavor described by Lawrence in 1726 was probably a form of rancidity. Rancidity goes by a number of different names such as bitter, rancid, goaty or wintry flavor. In a milk form it is also frequently described as an unclean or cowy flavor. The bitter rancid flavor always develops after milking. Twenty years ago investigators tried to explain the defect as of bacterial origin. It is now generally agreed that lipase causes rancidity. The best general recommendations for the control of rancidity are (1) feed the cows a ration of good quality, (2) do not subject the milk or cream to vigorous agitation nor to temperature fluctuations during storage, and (3) ship regularly. H.P.

**432. Raw Milk Contamination in Homogenized Milk.** A. V. Moore and G. M. Trout. Canad. Dairy and Ice Cream Jour., *25*, 7: 33. July, 1946.

Observations with respect to development of rancidity, titratable acidity, pH and phosphatase tests were made in five series of homogenized and non-homogenized milk to which various increments of raw milk had been added. During storage at 40° F. raw-milk-contaminated homogenized milk increased in titratable acidity, decreased in pH and developed rancidity. As little as 0.5% raw milk could be detected by the phosphatase test, questionably when 0.1% was added, but not when 0.05% was added. At 24 hours storage contamination of homogenized milk with raw milk must be at least 4% before rancidity can be detected by taste and smell. Extracting

the phenol with butyl alcohol should be a required step and not optional in the phosphatase test, particularly when applied to homogenized milk. H.P.

**433. Use of Composite Milk Samples for Making Sediment Tests.** E. G. Hood and I. Hlynka. Canad. Dairy and Ice Cream Jour., *25*, 9: 27. September, 1946.

The sediment test consists of filtering a definite quantity of milk through 1½ inch linten filter-discs. The sediment present is an indication of the care used in handling or producing milk on the farm. The use of the sediment test can be greatly extended among cheese-factory patrons provided the test is made on composite samples of milk so as to reduce the amount of work. The test is carried out as for regular composite samples only for an Imperial pint, three ½-oz. dippers of milk are required daily over a period of 13 days, or for a U. S. pint, 2 dippers for 14 days would give an adequate amount of sample. The samples are heated to 70° F. or above before making the test. The sample is inverted two or three times and transferred to the sediment tester. The bottle is half-filled with hot water 130–140° F., rinsed, and the rinse water passed through the same disc. H.P.

**434. Significance of Concentration of Coliform Organisms in Raw Milk upon Survival of Pasteurization.** J. E. Craige, Veterinary Section, Ninth Service Command Medical Laboratory, Presidio of Monterey, California. Jour. Milk Technol., *9*, No. 4: 191–196. July–August, 1946.

Eight strains of Escherichia-Aerobacter organisms were isolated from raw milk, pasteurized milk and ice cream, and were able to survive in milk at 62° C. for 30 minutes when present in sufficient number. None of these microorganisms survived when the concentration before pasteurization was less than 700 per ml.

Pasteurized milk should not be considered satisfactory for human consumption if the milk is positive for coliform organisms in more than two of five 1-ml. samples.

When coliforms are persistently present in the pasteurized milk, the causes may be due to (1) contamination after pasteurization, (2) inadequate pasteurization, (3) improper handling of the milk after pasteurization, (4) excessive numbers of coliform organisms in raw milk, and (5) heat-resistant strains.

The use of the phosphatase test, the standard plate count, the coliform test, laboratory pasteurization of raw milk, and other special techniques, in addition to line samples taken at the plant, are recommended procedures in order to determine the specific cause of contaminations that are difficult to control. H.H.W.

**435. Le Controle de la Pasteurisation du Lait et de la Crème. (The Control of Pasteurization of Milk and Cream.)** JEAN PIEN. Le Lait, *25*, No. 249–250: 310. 1945.

Tests for the presence of peroxidase in milk, cream, and butter have long been used as indicators of the effectiveness of pasteurization. Such methods as those of Dupouy (guaiacol), Storch (paraphenylenediamine) and Rothenfusser (a combination of the two previous tests) all lack reliability in cases where iron or copper are contaminants. The Schardinger reaction (a test for the presence of aldehyde dehydrogenase) is not affected by metals. In it, 10 ml. of milk to be tested is allowed to react at 50° C. with 0.5 ml. of an aqueous solution containing methylene blue and formaldehyde.

The results of a number of parallel trials are presented in which milk samples were heated to temperatures ranging from 72 to 83° C. for periods ranging from less than 10 seconds to more than 30 minutes. The results indicate that the Schardinger enzyme is slightly more sensitive to heat than is peroxidase when the latter enzyme is tested for by the Dupouy test. If the Schardinger reaction is negative after 4 hours incubation, proper pasteurization is indicated. It is suggested that this test is preferable for cream. O.R.I.

**436. Antagonisme du Colibacille et des Bacteries Padrides Dans le Lait Contaminé. (Antagonism of Coliforms and of Putrefying Bacteria in Contaminated Milk.)** A. ROCHAIX AND F. SIMON. Le Lait, *25*, 244–246: 144. 1945.

The authors have made a comparison of the relative growth of coliform organisms as against putrefying bacteria, the latter consisting of types capable of liberating hydrogen sulfide and of producing black colonies in a lead acetate medium. It is shown that a marked antagonism exists between the two types, in some cases either type completely inhibiting the growth of the other. The mechanism of antagonism is apparently not due to the high acidities or free hydrogen sulfide but to more complex antibiotic agents. O.R.I.

**437. Milk for Manufacturing Must Be of Top Quality.** J. C. HENING. Canad. Dairy and Ice Cream Jour., *25*, 9: 43. September, 1946.

Milk for the army was rejected if it did not attain the high standards set according to recognized standard tests. The methylene blue reduction time, direct count, plate count, and sediment testing were used as the standard tests. The Quartermaster Food and Container Institute had mobile laboratories for making chemical and bacteriological tests at canning plants. Dairy plants making dry whole milk, dry non-fat milk solids, and dry ice cream mix also used these mobile laboratories. The tests run on the farm-

ers' milk and composite samples of milk were resazurin, methylene blue, standard plate count, direct count, thermophiles, coliforms, and anaerobes. Within the plant the bacteriological tests made were standard plate count, direct count, thermophiles, coliforms, and anaerobes. Samples for these tests were taken after separation, after standardization, after preheating, and prior to drying. Other tests determined were acidity, pH, oxidation-reduction potential, copper, ascorbic acid, titration to a pH of 4.63, and conductivity. H.P.

**438. The Responsibility and Work of Milk Sanitarians.** C. C. HADLEY. Canad. Dairy and Ice Cream Jour., *25*, 9 : 30. September, 1946.

A milk sanitarian is a person making a profession of the application of sanitary and health measures to the production, processing and distribution of milk and milk products for the public benefit. The training for employment as a milk sanitarian should be somewhat broader than those provided by the usual dairy curriculum. There is no line of demarcation between the primary interests of the producer, processor and the sanitarian in the production of high quality, sanitary milk, and milk products. H.P.

**439. Types of Refrigeration for Market Milk Plants.** A. A. GEIGER. Canad. Dairy and Ice Cream Jour., *25*, 5 : 42. July, 1946.

The refrigeration should be designed to have sufficient flexibility to easily handle the maximum load and still require no hand regulation of control valves for minimum loads. The three types of refrigeration are brine, direct expansion of refrigerant, and sweet water. The single aim for each system is to store up refrigeration during the night to be used the following day. Ice bank storage is not conducive to the processing of good milk. For a small plant a cabinet type water cooler or a brine cooling system can be used. Refrigeration requirements are figured for a plant bottling around 1500 gallons per day. Brine system is adaptable to a plant of this size better than an instantaneous water cooler. Direct expansion is not advisable for use in the majority of small plants. The major reasons for this are: (1) the cost is not justified on small volumes, (2) complicated controls, (3) this system is more subject to short-cycling of compressors operation, (4) it is expensive. H.P.

## PHYSIOLOGY

**440. Blood Levels of Calcium and Inorganic Phosphorus in Hereford Cattle.** MERLE G. PAYNE, A. S. CLARK, H. E. KINGMAN, AND W. M. STANBURY. Jour. Agr. Res., *72:* 12. June 15, 1946.

The normal blood levels of phosphorus and calcium for range Hereford yearling and herd bulls and for range Hereford heifers and aged cows was

determined on 560 arrivals. The normal levels for blood serum inorganic phosphorus in milligram per cent were $7.30 \pm 0.103$, $4.76 \pm 0.099$, $5.07 \pm 0.063$, and $4.89 \pm 0.101$ for yearling bulls, herd bulls, 2-year-old heifers, and aged cows, respectively. The phosphorus level of blood was found to be greater in bulls than in cows. The quantity of phosphorus diminishes with age in Hereford range cattle, but this relationship with age is stronger in the male animal. The normal levels of blood calcium in milligram per cent were $10.46 \pm 0.238$, $13.03 \pm 0.256$, $9.13 \pm 0.158$, and $9.52 \pm 0.249$ for yearling bulls, herd bulls, 2-year-old heifers, and aged cows, respectively. A complementary association of phosphorus and calcium has been found. The calcium-phosphorus ratio in homogeneous groups is a variable concept depending on age and sex. H.P.

**441. The Component Acids of Cow Colostrum Fat.** C. P. ANANTAKRISHNAN, V. R. BHALE RAO, AND T. M. PAUL, Imperial Dairy Research Institute, Bangalore (India). Biochem. Jour., *40*, No. 2: 292–297. 1946.

The colostrum was collected from six different cows, representing four different breeds of India cattle. It was then diluted with water and the cream separated. The butterfat was then prepared by the "boiling off" method. Tables giving the more common physical constants of the individual samples, as well as a composite mixture, for the first to fifth, tenth, and fifteenth days of lactation, are shown. The mixed composite samples for each day were converted to methyl esters and fractionated. The transition from colostrum to normal milk was accompanied by an increase in the saponification and Reichert values and a decrease in the butyro-refractometer reading, the iodine values, and the melting point. "The first day's cow colostrum fat compares favorably with the mature human milk fat, the percentage of lower acids up to $C_{14}$ being almost the same (16.4 and 17.8, respectively)." A.O.C.

**442. Le Colostrum de Vache. (Cow's Colostrum).** A. HOUDINIERE. Le Lait, *24*, No. 234–236: 108, No. 237–238: 226, No. 239–240: 313, 1944; *25*, No. 241–243: 27, No. 244–246: 97, 1945.

The changing properties of colostrum are fully reviewed, French, German, English, and American literature all being reported. Under physical properties, freezing point, specific gravity, viscosity, surface tension, index of refraction, and electrical resistance are dealt with. The increased content of albumin, globulin, and soluble phosphates influence creaming, heat coagulation, titratable acidity, and pH. Acid precipitation of the casein is interfered with because of the high level of albumin and globulin. Colostrum contains large numbers of cells, many of which appear to be of blood origin. By classifying the cellular material it is possible to determine

whether the colostrum is from a healthy or infected udder. Phagocytes are present in colostrum and its bactericidal properties are more marked than those of fresh milk. It is particularly rich in opsonins and contains agglutinins, precipitins and lytic antibodies for some types of organisms. The antibiotic properties of colostrum should be studied in relation to mastitis organisms, the author states.

Catalase activity is 10 to 12 times greater than in milk; lipase and amylase activities are greater, but Schardinger enzyme, protease, and phosphatase activities are less. Among the vitamins, the data available indicate that most of these factors are richer in colostrum. The saffron-yellow color is due mainly to carotene and riboflavin.

The energy value of colostrum is upwards of twice that of milk. Digestibility and action of rennet are discussed extensively, as is the physiology of secretion. The author points out that colostrum was probably the major product of the mammary gland until man began to select and breed animals for more persistent milk production.

The extent to which colostrum may be present in a milk supply can be determined from the relative proportion of "holoproteins" (albumin and globulin) to the total protein. The various effects which the presence of colostrum might have upon almost all types of dairy manufacturing are fully but somewhat speculatively discussed on the basis of the properties of colostrum. 273 references are cited. O.R.I.

**443. La Genotypicité des Enzymes Microbiens Illustrée par les Ferments Lactiques. (Specific Genotypes of Microbial Enzymes Illustrated by Lactic Ferments.)** COSTANTINO GORINI. Le Lait, *24*, No. 237–238. July–September, 1944.

Production of enzymes by bacteria affords a means of establishing classifications. The author claims that bacterial species display a similarity to other biological genotypes in that descendants are similar to parents, yet at the same time individual cells vary from type somewhat. Dissociation in the bacterial cell increases this tendency toward variation because it aids a bacterial species in adapting itself to new media. The work of several bacteriologists is cited to show that, in the case of the lactic acid bacteria, recognition of this adaptive faculty has resulted in unifying several sub-species of organisms into one species. O.R.I.

## MISCELLANEOUS

**444. Values of Cleaners in the Dairy Industry.** V. E. GRAHAM AND G. E. TURNER. Canad. Dairy and Ice Cream Jour., *25*, 7 : 27 ; *25*, 8 : 36. July–August, 1946.

The residues to be removed from dairy equipment consist of milk fat,

milk proteins, and the salts of milk, together with those salts which are formed as a result of chemical combination between the salts of the water and milk solids. The fat and most of the milk proteins are not soluble in water. Commercial cleaners usually remove dirt by one or more of the following procedures, namely: solution, emulsification, wetting, deflocculation and foaming. The washing problem is simplified when dairy plants have a soft-water supply. Hard water causes precipitates with some cleaners and influences milkstone formation. Any compound to be valuable as a cleaner must possess one or more of the following qualities: (1) wetting power, (2) emulsifying power, (3) deflocculating power, (4) dissolving power, (5) water-softening power, (6) free rinsing, (7) inert towards metals, (8) cost. The advantages and disadvantages of the common alkaline cleaners are considered. The ones mentioned are sodium hydroxide, sodium carbonate, trisodium phosphate and sodium metasilicate.

Milkstone removers are nearly all acid substances or mixtures of acids. The common acids used are hydrochloric, tartaric gluconic, or citric acid. New ideas in cleaners eliminate precipitates with hard water and increase wetting power. Complex sodium phosphates are satisfactory as they do not form precipitates with hard water, are non-corrosive, prevent milkstone formation, and have good wetting powers. Most wetting agents are sulphonated alcohols, sulphonated esters and sulphonated ethers. Special cleaning directions are given for each piece of equipment, including receiving and storing equipment, can washing, bottle washing, preheating equipment, plate heaters, churns, floors, walls and painted surfaces, aluminum equipment, glass enamel, and stainless steel. H.P.

**445. Softening and Purifying Water for Use in Dairy Plants.** C. E. LENNOX. Canad. Dairy and Ice Cream Jour., *25*, 7: 35. July, 1946.

In getting a plant water supply one must take into consideration: (1) source of water, (2) sources of impurities, (3) suspended water, (4) taste, odor, and color, (5) hardness, (6) iron, (7) bacteria. Notable hard-water troubles in the dairy are (1) boiler operation, (2) hot-water supplies, (3) can washing, (4) bottle washing, (5) water-cooling coils, (6) equipment cleaning, (7) washroom maintenance. Several processes or types of water softeners are available: (1) hot process lime-soda, (2) cold process lime-soda, (3) siliceous zeolites, (4) carbon-type exchangers. H.P.

**446. Seeing Is Believing in Sanitary Control.** M. C. JAMIESON, K. H. CHEN, AND D. A. WILLIGAN. Canad. Dairy and Ice Cream Jour., *25*, 7: 52. July, 1946.

A simple procedure for assisting eating and drinking establishment personnel in sanitation problems involves a suitcase type of laboratory based

on the swab-streak principle. The procedure from swabbing of the surfaces to the examination of the results is carried out in the establishment. Sufficient detail is presented to enable anyone with access to a bacteriological laboratory for the preparation of supplies to apply the method in any educational or control program. H.P.

**447. Freon and Ammonia Mechanical Refrigerants.** T. M. HUGHEY. Canad. Dairy and Ice Cream Jour., *25*, 6 : 31. June, 1946.

In the past few years several refrigerants have been utilized and new ones developed. Ammonia has been used since mechanical refrigeration was invented. The selection of a refrigerant depends upon the type of machine or system in which it is to be used. The ASRE Data Book lists approximately 30 refrigerants. During the war different Freon liquids were shown to be good refrigerants using much lighter equipment and suitable for heavy and for lighter jobs where leakage would not spoil foods. For maximum economy, ammonia still holds its place in the industrial field. On small and fractional tonnage application, its use is diminishing. Operation costs per ton, both theoretical and practical, are lower for ammonia than any other refrigerant used in industrial systems. The properties of ammonia are well established. Freon as a group has many desirable properties such as (1) lower pressures, (2) constructed of lighter materials, (3) it is an active cleaning agent, (4) it is not miscible with water, (5) it is odorless and non-toxic, (6) it is a very stable refrigerant. H.P.

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## ERRATA

Vol. XXIX, No. 4, page A55. Abstract No. 106. The fifth sentence of this abstract should read: Cheese from milk pasteurized at 143° F. for 30 minutes or 162° F. for 15 seconds did not give values greater than 5 units, regardless of the age of the cheese.

Abstract #170, Vol. XXIX, No. 6, June, 1946, page A84—title should read: Bulk Freezing for Commercial Use.

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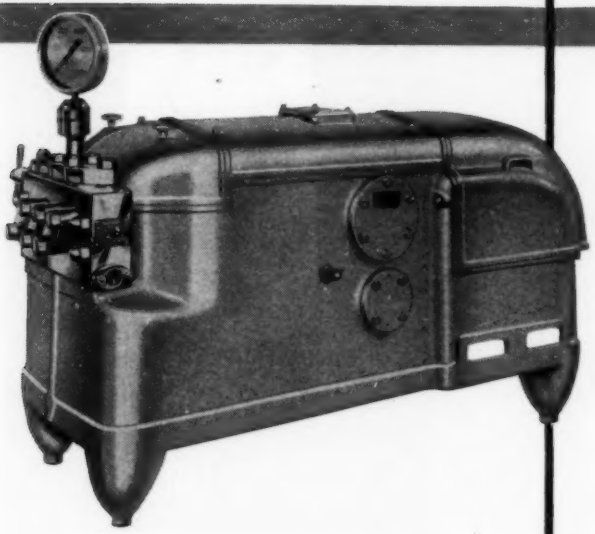

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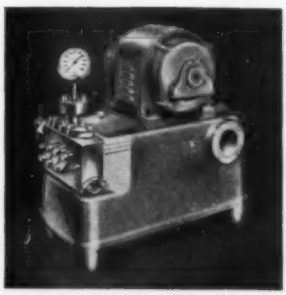

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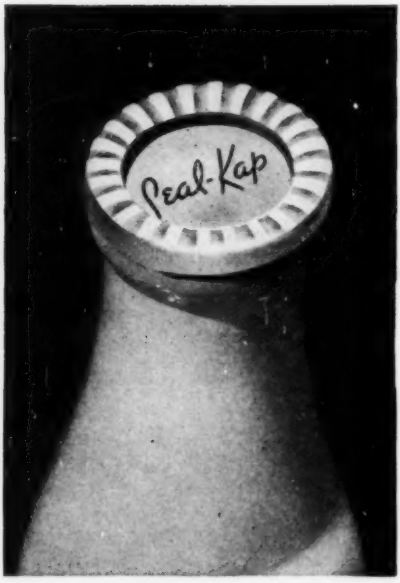


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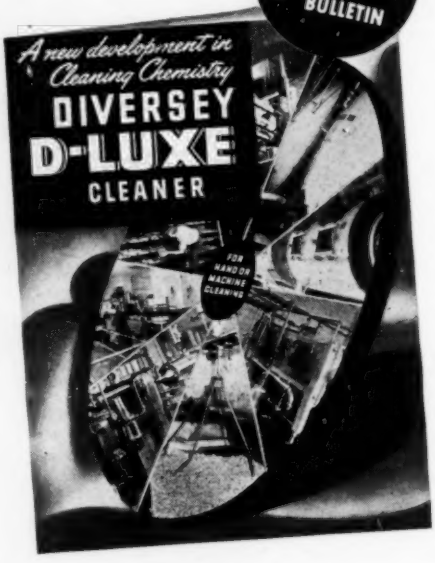


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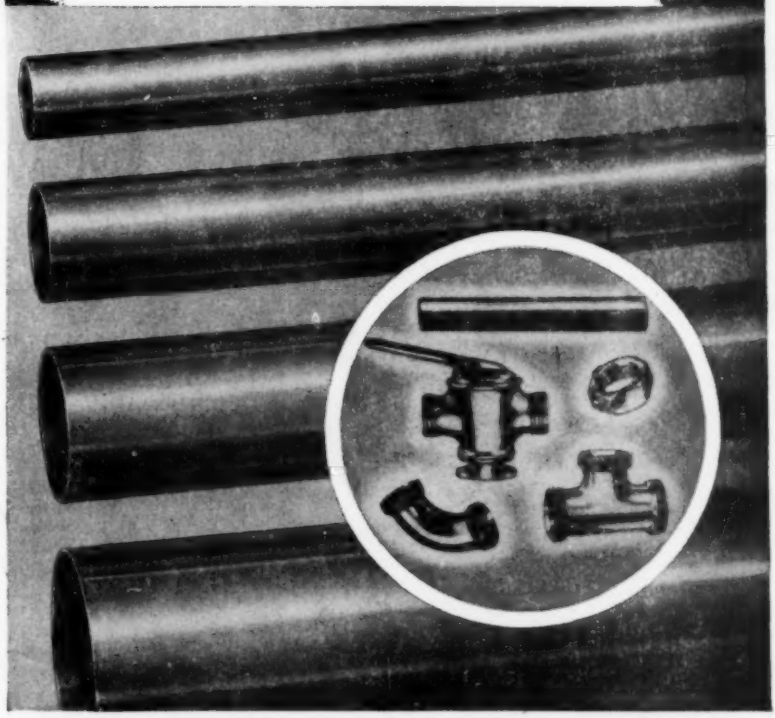

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